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NEW YORK, AUGUST, 1891.

THE Council of the Royal Society of Arts has been constituted a Commission by the British Government to represent it and to look after the interests of British exhibitors at the Columbian Exhibition in Chicago. The Prince of Wales is Honorary President of this Commission; its Chairman is Sir Richard Webster, and its Secretary Sir Henry Wood. There are 36 members, prominent among whom are Mr. James Dredge, Editor of *Engineering*, and Sir Philip Cunliffe Owen, both well known in the United States.

THE Massachusetts Company of the Naval Reserve or militia had a term of practical drill during the visit of the Squadron of Evolution to Boston in July. The men were exercised on board ship and at the guns, receiving a short but strict tour of instruction.

The New York Naval Militia has been completely organized. As mustered into the State service, the battalion numbered 201 men, under command of Lieutenant-Commander Jacob W. Miller, Lieutenants S. D. Greene, W. B. Duncan, Jr., L. Mowbray, and L. M. Forshew. A period of sea drill was had on the squadron evolution, in the third week in July.

A battalion of naval militia will probably be organized at Norfolk, Va. A movement for enlistment has been started there and is in excellent hands. Norfolk presents many advantages as headquarters of a battalion.

SOME additional trials have lately been made at Annapolis with comparatively light plates treated by the Harvey process. These plates are of 3-in. steel; the gun used was a 6-pdr. Hotchkiss cannon, using forged steel projectiles, and giving an initial velocity of about 1,800 ft. The results have been very favorable, the plates resisting successfully all the shots fired.

AN interesting competitive test of heavy rapid-fire guns will soon be begun at the Army proving grounds at Sandy Hook, New York Bay. Three guns have been entered for this test, one American, the Hotchkiss 4.7-in. gun; one French, the Canet 15-cm. (5.9-in.), and one English, the Armstrong 4.72-in. These are the heaviest rapid-fire guns yet brought forward, with the exception of the Armstrong 6-in. gun, which has lately been tried in England. The Hotchkiss and the Armstrong guns at Sandy Hook are practically of the same caliber, and their projectiles are also nearly of the same weight, about 60 lbs. The Canet gun is over an inch larger in caliber, but the weight of its shot is not very much greater. The Hotchkiss and the Canet guns will use French smokeless powder; the Armstrong gun cordite powder. The tests will include both rapidity and accuracy of fire, and also the resistance of the guns to continued use.

THE great 125-ton steam hammer at the Bethlehem Iron Works—the largest in the world—has been completed, and has begun its work of making heavy forgings for guns and armor plates. The size of this hammer may be estimated from a few figures. The pit for the foundation was 58 × 62 ft., and the foundation walls are 30 ft. in height. The anvil, which is entirely distinct from the hammer, is built up on a foundation of stone and timber, and has some 1,800 tons of iron in it. The top of the hammer is 90 ft. above the floor of the shop; the steam cylinder is 6 ft. 4 in. in diameter and 16 ft. 6 in. stroke. The piston-rod is of steel and is 16 in. in diameter and 40 ft. long. The hammer-head is of cast iron, the block being 19½ × 10 × 4 ft., and the die or hammer face is of steel. The weight of the working parts, by which the hammer is rated, is 125 tons altogether, and the full force of the blow given by this weight of metal falling 16½ ft. may be estimated.

The hammer stands in a building erected purposely to hold it, and is provided with cranes and other appliances for handling the enormous ingots which will be forged into shape under it. The Bethlehem Company has certainly shown great enterprise in undertaking the establishment of the great plant for armor and gun forgings, which it has now nearly completed.

THE Postmaster-General has issued the advertisements of mail lettings for ocean service under the Postal Aid Bill passed by the last Congress. The advertisements call for bids for mail service in American built ships from a number of ports, the chief lines named being from New York, Boston, and Baltimore to European ports; from New York and Philadelphia to Buenos Ayres; from Baltimore and Norfolk to Brazilian and West Indian ports; from Port Tampa to La Guayra and Santos; from New Orleans and Galveston to Colon; from New York to San Francisco *via* Panama; from San Francisco to South American ports, to China, Japan, Australia, and New Zealand; from New Orleans to the principal ports on the Spanish Main; a number of lesser routes are also included.

A number of the lines advertised are already in existence, but a number proposed are entirely new. The law provides a rate of $4 per mile for first-class service—that is, in 20-knot steamers of not less than 8,000 tons; for second-class service—in 16-knot ships of 5,000 tons or over—$2 per mile; for third-class—14-knot vessels of 2,500 tons or over—$1 per mile; and for fourth-class—12-knot ships of 1,500 tons—66⅔ cents per mile.

To meet the first-class standard, a number of new vessels will have to be built, and three years' time will be allowed to fill the conditions. Vessels approved for mail service under this law must be owned and built in this country, must be officered by American citizens, and must be adapted for use as cruisers in case of war, in the higher classes; the lower classes of ships not fitted for cruisers to be subject to use as transports, if needed.

Contracts are to be made for 10 years, and the date for opening bids is October 26 next.

THE formation of a lake of considerable extent though of no very great depth is reported in the Colorado Desert, the nearest point of settlement being Salton Station, on the Southern Pacific Railroad. The lake has grown gradually and steadily for some time, but no damage has been done, as the country is entirely without settlers. It has its origin in an overflow of the Colorado River into the great desert basin, most of which is considerably below the level of the sea, and which was undoubtedly at one time connected with the Gulf of California.

ENGLISH AND AMERICAN LOCOMOTIVES.

IT should be mentioned at the beginning of this article, that it is merely a sort of reconnoissance of the position of the *Engineer* on this subject. Several months ago we promised our readers and our contemporary that we would collect and publish some statistics relating to the performance of American locomotives. As was intimated at that time, data which will enable us to make comparisons of the performance of American locomotives with that of their English contemporaries, which will have any value, are not easy to obtain. Many of our railroad companies do not keep any account of the consumption of fuel of their locomotives, and some of those which do give no reports of loads hauled. Besides this difficulty, the forms and methods of keeping these reports vary a great deal on different roads. From some of them we have received most elaborate reports, printed on several large sheets 19 × 36 in. in size, on which statistical information is given in the utmost detail. Other reports are printed on the back of a postal-card, and consequently the information given is very meager. Even when the records contain data which is needed it must usually be carefully analyzed and tabulated before any comparisons can be made or reliable conclusions drawn therefrom.

To be able to compare the performance of locomotives here and in a foreign country, it seems to be essential to know:

1st. The average number of miles which such machines run in a given time here and there.

2d. The average loads hauled.

3d. The amount of fuel consumed per mile run.

4th. The cost of repairs per mile run.

5th. The other running expenses, including oil and waste, wages of locomotive runners and firemen, cleaning engines, etc.

While this information cannot be obtained from all our companies, yet many of them can furnish such data, and, from what we regard as reliable sources, we have collected the items of information referred to above concerning the performance of from 7,000 to 10,000 locomotives in different parts of this country.

In the *Engineer* of November 7 of last year an elaborate table was published in which information was given with reference to the mileage, fuel consumption, cost of repairs and "cost of working" of locomotives in the United Kingdom. It was not stated what was included under the head of "cost of working," and the train loads were not given, although the traffic receipts per train mile were. Therein lies our difficulty, and we ask the aid of our contemporary to help us out of it. If there is any way of ascertaining the average weight of the trains hauled by British engines, it would make it possible to compare the performance of locomotives here and there. Without such information it is not comparable.

In a report made to the British Board of Trade in 1887 it is said that "passenger mileage and ton mileage are not required to be shown in the returns annually made by the companies under Act of Parliament." As we have not been able to find such data in any of the Board of Trade or other reports to Parliament which are accessible to us, we infer that such statistics are not kept, or are not published by English railway companies. In the absence of such data the average train loads could be calculated approximately from the traffic receipts if the average rates per ton per mile for carrying goods was known. Although it may not be possible to ascertain what the average rate is, it should be practicable to fix some maximum and minimum limits for the average rates. In a "Return" by the Railway Companies in the United Kingdom to the House of Commons showing the Rates charged for the carriage of various articles, dated February 1, 1887, we find very few rates less than a penny a mile, and nearly all are more—some of them very much more. Our inference is that 1*d.* per ton per mile would be a very low estimate of the average railway rate for carrying goods on British roads. As the average traffic receipts per goods train mile is given by the *Engineer* as 5*s.* 10.08*d.* on all the roads of the United Kingdom, if the average rate is not less than 1*d.* per ton per mile the average paying load cannot exceed 70.08 tons. If the dead-weight of the cars or wagons is equal to the paying load, the average weight of the trains exclusive of the engine and tender would not exceed 140.16 tons. If the dead-weight is twice the paying load, the trains would weigh 210.24 tons, but would not exceed that amount. Can the *Engineer* throw any light on this?

In a recent review of "The Railways and the Traders; a Sketch of the Railway Rates Question in Theory and Practice," by W. M. Acworth, it is said that "in this country" (presumably Great Britain) "300,000,000 tons were carried in 1889 for £40,000,000 sterling, or at an average cost of 2*s.* 8*d.* per ton." There is no means of arriving at the average distance each ton was carried. Mr. Acworth (Chapter IX.) puts it at 25½ miles, which brings the cost to 1¼*d.* per mile.

It ought to be possible to know with more or less definiteness whether the average rate for carrying goods in the United Kingdom is less than a penny per ton per mile, or more than twopence. Is the average rate less than a penny per mile or more than twopence, and is the dead-weight of cars on British roads more or less than the paying weight of goods, and what expenses are included under "cost of working"? The *Engineer* must have sources of information with reference to these points which are not accessible to us, and if these questions were answered it

would help very much to clarify the discussion of this subject, which, it must be admitted, has at times been somewhat turbid.

THE DANGER FROM LOCOMOTIVE CHECK-VALVES.

One of the most horrible in all the dreadful record of railroad accidents occurred on the Colorado Midland Railroad, at Aspen Junction, Col., on July 11. The daily papers publish the following report of it:

A party of Midland officials have made a preliminary investigation of the accident and its causes. Their report of the affair differs materially from that first given out. It is as follows:

A freight-train was standing on a side-track alongside the main ready to be pulled out by Engineer Sheperd with the engine which was coming out of the roundhouse. The switchman had thrown the switch for the light engine when he noticed the excursion train backing down from the tank. He immediately signaled both trains to stop, which they did. He then signaled the light engine to back up, and the brakeman on the rear end of the passenger train, which had been backing up, also took the order. The result was a "cornering" of the coach and the engine at the switch, the window of the compartment coach taking off the check-valve as before stated. The light engine immediately stopped, and the opening in the boiler made by the loss of the valve being directly opposite an open window in the compartment of the coach which contained all the passengers except the three colored men, belched forth its awful death-dealing vapor. All the other windows and doors of the car were closed, hence the compartment took on the nature of a steam chest. The pressure of the steam in the close compartment was so great that when a door was finally knocked open from without, the liberated steam threw the rescuer violently on his back. The nature of the accident is such that it is a wonder that any of the occupants of the coach are living. Joseph Leonard's flesh was so thoroughly parboiled that when he attempted to knock out a window with his hand his flesh stuck to the glass.

On the 13th it was announced that the eighth victim had died, and that four others cannot survive. A faint idea may be formed of the inexpressible and inconceivable horror of this accident on reading that one of the victims had not a particle of skin on her hips, and of another that the skin was almost entirely scalded from his face and shoulders.

Accidents of this kind have occurred before. It will be remembered by some of our readers that in 1880, in a collision on the Pennsylvania Railroad, just east of Pittsburgh, a large number of people were scalded to death from exactly the same cause. A local train was standing at a station and a following train ran into it. The colliding engine telescoped the rear car of the front train, and in doing so knocked off the check-valve case, and the hot water and steam were discharged from the boiler into a crowded car. The scalding of passengers in the May's Landing accident on the West Jersey & Atlantic Railroad, also in 1880, was probably due to the same cause. On the Cincinnati, Hamilton & Dayton road another accident occurred, in 1880, in which a number of people were scalded, but it was owing to a blower-cock being broken off.

If such occurrences could not be prevented they would be the occasion for the exercise only of fortitude and resignation on the part of the sufferers and their friends, and of sympathy by those who contemplate the affliction of the victims. But if they can be prevented they should be a powerful stimulus to every railroad officer in the land to seek for remedies which will prevent similar disasters in future. There is no excuse either for the non-exercise of vigilance and energy for the prevention of this class of accidents, because preventative means are within easy reach. As the danger is due to the exposed position of the check-valves, the thing to do is to remove them to safer positions. This can readily be done by placing the injectors and the check-valves on the back end of the boiler, and running the feed-pipes to the front end of the tubes inside—instead of outside—of the boiler. This is a general practice in England, and also on the Canadian Pacific Railroad, of which an illustration was published in the Journal of August, 1888, and may be found in the new edition of the Catechism of the Locomotive, page 235.

Another method is the use of a safety check-valve; that is, one with the valve inside the boiler, so that if the case or pipe outside is broken off, the valve inside will close and prevent the escape of steam or hot water. A device of this kind was illustrated in the Journal last month, and another, also illustrated and described in the new edition of the Catechism of the Locomotive, is the invention of Mr. Hayward, Superintendent of Machinery of the Pennsylvania Railroad, at Jersey City, and is in use on that line. Any of these would have prevented the lamentable accident which occurred at Aspen Junction a short time ago, and that which happened near Pittsburgh in 1880, and if adopted now would doubtless prevent other equally dreadful calamities in the future. It is to be feared, though, that unless legislative pressure is exerted on them, the railroad companies will not show great alacrity in adopting such safeguards. The danger seems remote, and accidents of this kind are not very frequent, and are rarely or never repeated in the same place. The dreadful lessons which they teach are soon forgotten, and are seldom or never repeated to the same people. Indifference is so easy, and vigilance so difficult, and habit so hard to uproot. Railroad Commissions are, however, created for the purpose of stimulating the lagging efforts of railroad companies in just such directions as this. The subject is respectfully called to their attention. A circular from these officials to the managers of railroads, asking what measures have been taken to guard against such accidents as that which occurred at Aspen Junction, would compel the managers to give the subject sufficient thought to answer the inquiry, and that would be a step gained. As such accidents can easily be prevented, with little expense to railroad companies, at least all new locomotives which are built hereafter should have adequate safeguards for the prevention of such calamities in future.

NEW PUBLICATIONS.

Pantobiblion. *International Bibliographical Review of the World's Scientific Literature.* Edited by A. Kersha, C.E. St. Petersburg, Russia.

This is the first number of a monthly publication, the object of which is to help technical and scientific students by keeping them informed as to all the literature of interest to them which may be published from time to time. It will aim to present a classified list of all new books issued in civilized countries on scientific subjects; critical notices of all the more important works which may appear from time to time; a review of current periodical literature, and finally brief notes on scientific topics.

The Editor has thus laid down a sufficiently ambitious programme, and to carry it out will require hard and constant work. To follow up the periodicals alone, one would suppose, would be a sufficiently serious task. For the first number some shortcomings are admitted, chiefly due, it is said, to the failure of publishers to respond promptly to requests for information, and it would not be fair to criticise the opening number too closely.

For European publications and periodicals M. Kersha has

done very well, but his American list is very defective. This, however, may be remedied in future numbers.

The classification and arrangement are good, and a regular reader will soon learn to turn at once to the subject which interests him. The remarks on each book or journal and the criticisms of those books which are noticed are given in the language in which the book itself is printed, so that a page of French may be followed by one of German, that again by one of English or Spanish, and one must be a linguist of some ability to read steadily. The book, however, may be of considerable value to students and readers.

THE OFFICIAL RAILWAY LIST. *A Handbook of Useful Information for Railway Men. Tenth Year*, 1891. Walter D. Crosman, Editor. (Chicago; the Railway Purchasing Agent Company, No. 816, the Rookery.)

This is the tenth number of a very useful work. It is a directory of railroad officers in the United States, including not only the general officers, but also those of the operating, traffic, maintenance of way, motive power, and car departments. The value of such a book is, of course, in its reliability; and long experience with the *Official List* as a desk companion has proved that the editor and publisher take much pains with their work, and that the yearly volumes are kept well corrected up to the date of their publication.

The book may be said to serve also as a directory of dealers in and manufacturers of railroad supplies, since those classes of business men have become so accustomed to advertising in its yearly issues that the list of those who are absent is not a long one.

RETAINING WALLS FOR EARTH. *Including the Theory of Earth-Pressure as Developed from the Ellipse of Stress.* By Malverd A. Howe, Professor of Civil Engineering, Rose Polytechnic Institute. (John Wiley & Sons, New York; price, $1.25.)

This is the second edition of Professor Howe's book, the first having come already to be considered a standard work. The first edition was based upon the theory of Weyrauch, but in the present one new and shorter demonstrations have been presented. These give the same results, but are, it is believed, more direct and simple. To permit comparisons, however, Weyrauch's demonstrations are given in an appendix.

An addition made in the present edition is a chapter on the supporting power of earth in the case of foundations; another is a formula for determining the breadth of the base of a retaining wall. Both of these will be useful to engineers in many cases.

Professor Howe has treated his subject as briefly as possible, giving the formulas first in a condensed form by themselves, and then following with examples illustrating their application. Tables of strength and weight of various kinds of stone, of co-efficients of friction, and of other co-efficients used in the formulas are appended.

The book is a useful one both for students and for engineers in practice, and requires little criticism. The diagrams and illustrations are generally good, although some of them would have been clearer had they been made on a larger scale.

COMBUSTION IN THE FIRE-BOX. By Ira D. Stocking, Troy, Kansas.

This is a small pamphlet of eight pages, of which the author says, "you will see some ideas that has never been advansed, if so I never have sene them. in the artickle I no doubt have used the Languge of others in expressing myself, but could it be otherwise, as we all must Learn from others."

A few quotations will give an idea of the character of this "artickle." The author says:

As all subjects must have a foundation, or a starting point, for the benefit of listeners who are supposed to be students on this occasion, our first lesson will be in the elementary department of chemistry, its action in the fire-box to assist in the producing of steam and to make a beginning of this subject we must understand some of Nature's laws, which is both proper and right. If it is no crime to understand the chemical properties of the vegetables we eat, what can be the objections of understanding the chemical properties of the atmosphere we breathe.

But science has scarcely reached the primary department of this, as well as numerous other subjects and consequently it cannot be expected.

Fathom only the shoals of such a boundless problem. But science, in its infancy, is driving before it the fog of prejudice and superstition from the fields of thought and securing to itself the right to explore, without limit to its boundless magnitude.

And now I will return to my subject again. Air and atmosphere is the two first principles in Nature, but are two distinct elements, but their relations are such, in the developing of Nature, as to be indispensable to each other, as it cannot act as an invigorator in the developing of vegetable or animal life for want of the vital fluids and gasses, but when combined readily fill all these requirements. Air in its original condition is not transparent, as is the general supposition, as it is void of a prismatic vapor. But before further proceedure with this subject I shall be obliged to use the term compound a great many times, it may be well enough to give its meaning a little attention, what is meant by a compound is the mixing of any number of matters, either fluids or gasses or chemicals together in one mass. So when we mix air and atmosphere together we have a simple compound, but by this compound we have found a prismatic vapor and this compound of air is supposed to exist only 45 miles above the earth, and above this point all is darkness, as this prismatic vapor is the true origin of both light and heat.

The author is right; his "artickle" does contain "some ideas that has never been advansed," at least we have never "sene" them before.

CORNELL UNIVERSITY: HER GENERAL AND TECHNICAL COURSES. By Frank C. Perkins. (John Wiley & Sons, New York; price, $1.50.)

The reason for this book is not very apparent. It contains a brief account of the origin of Cornell University, which is followed by condensed descriptions of the different departments, written apparently to measure, since each occupies exactly a page, while the opposite page is taken up by an engraving showing the building devoted to the department, with a portrait of the professor in charge. There is an undue proportion of advertising—just one-third of the pages being given up to advertisements. We do not by any means wish to depreciate advertising or detract from its value; but in a book intended for permanent preservation, so large a proportion seems out of place. The engravings will doubtless be valued by graduates of the University; but beyond the pictures there is really nothing in it which cannot be found in a somewhat different—and probably more complete—form in the yearly catalogue of the University.

One thing must be said of the book, however—that the mechanical execution is very good. It is well done; and the printers—the Matthews-Northrup Company, of Buffalo—have obtained better results from the half-tone cuts than it is always possible to secure.

BEESON'S SAILORS' HANDBOOK AND INLAND MARINE GUIDE: 1891. By Harvey C. Beeson, late Marine Clerk of the Port of Detroit. (H. C. Beeson, Detroit, Mich.; price, $1.)

This handbook must be almost indispensable for lake shippers and navigators. It contains lists of all the American steam and sail vessels on the Northwestern Lakes; tables of sailing distances between lake ports; names of harbor-masters, port and customs officers; lists of light-houses, beacons, etc.; rules of the road; rules for pilots, and much other useful information, besides a variety of articles on ships and shipping and on maritime law and recent decisions. In a word, it may be said to be an almost complete compendium of information of the kind which a shipper or captain needs, arranged in a convenient way and given in a condensed form. The labor of pre-

paring such a book is not small, and the author deserves credit for the care with which it has evidently been done.

H. M. S. "VICTORY: HER HISTORY AND CONSTRUCTION. *With Special Reference to the Reproduction of the Ship at the Royal Naval Exhibition.* By Captain C. Orde Browne, R.A., and Assistant Constructor H. J. Webb, R. N. (*The Engineer*, London, England).

This is a descriptive and historical account, reprinted from the columns of *The Engineer*, of the famous old *Victory*, which in its prime was Lord Nelson's flagship, and took a prominent part in many famous naval battles. The historical part is, of course, very interesting; and the fully illustrated description of the ship is still more so, as a study of what was the best naval practice a century ago.

The contrast between the *Victory* and a modern war-ship is well shown by her armament. She was launched in 1765, and when she first went into commission carried 104 guns, as follows: Lower deck, 30 long 32-pdrs.; middle deck, 30 long 24-pdrs; main deck, 32 long 12-pdrs; upper deck, 12 short 12-pdrs. The "long 32s" were the heaviest navy guns of that day, and weighed 56 cwt. each; rather a contrast to the 110-ton guns of the *Benbow* or the *Anson*.

The care with which the *Victory* has been preserved and the interest with which she is regarded suggests a regret that some one at least of our own famous ships has not been preserved as an example. The old ships which first made the reputation of our navy are gone past recovery; but we still have the *Hartford*, the *Kearsarge*, and one or two others which have earned a name as fighting ships, and one of them at least ought to be kept for future generations instead of being broken up when her usefulness as a cruiser is over.

This monograph on the *Victory* is of interest to general readers as well as to naval men, and *The Engineer* has done them a service in reprinting it in a form convenient for reference.

EXPERIMENTAL INVESTIGATIONS BY THE STATE BOARD OF HEALTH OF MASSACHUSETTS UPON THE PURIFICATION OF SEWAGE AND THE INTERMITTENT FILTRATION OF WATER. *Made at Lawrence, Mass.*, 1888–90. (Boston; State Printers.)

This is Part II of the Report on Water Supply and Sewerage presented by the Massachusetts Board of Health. Part I treated of Water Supplies and Inland Waters.* The present volume gives the result of a long series of tests and experiments made under the direction of the Board, with a view of securing exact data; these were conducted at a station established for the purpose on the Merrimack River near Lawrence.

The principal part of the book is the Report on Filtration of Sewage and Water and Chemical Precipitation of Sewage, by Mr. Hiram F. Mills, a member of the Board, who had special charge of this work. This is followed by a report on the Chemical Work of the Station, by Dr. Thomas M. Drown and Allen Hazen; a report of Experiments on Chemical Precipitation of Sewage in 1889, by Allen Hazen; a report of the Biological Work of the Station, by Dr. W. T. Sedgwick; and lastly, investigations upon Nitrification and the Nitrifying Organism, by E. O. Jordan and Ellen H. Richards. The work is illustrated by a number of plates and diagrams, and is provided with an excellent index, a point too often neglected in reports of this kind. The whole forms a great body of information on the subject which must be of much value to the sanitary engineer.

With the modern tendency to concentration of population in towns and cities the questions of water supply and the disposal of sewage and refuse have come to be of the first importance. Too much work has been done in a blind, haphazard way, and the value of systematic investigations like those undertaken by the Massachusetts Board can hardly be overestimated. Undertaken in the first place for the benefit of the people of that State—peculiarly a State of cities and large towns—the results are applicable and useful everywhere, and a careful study of this volume will be well repaid.

* See JOURNAL for June, 1891, page 244.

REPORT OF THE BOARD OF RAILROAD COMMISSIONERS OF THE STATE OF NEW YORK ON STRAINS ON RAILROAD BRIDGES OF THE STATE. William E. Rogers, Isaac V. Baker, Jr., Michael Rickard, Commissioners; Charles F. Stowell, Bridge Engineer. (Albany, N. Y.; State Printers.)

The work of which this report is the result was undertaken by the New York Railroad Commission in 1884, when it had become apparent that some measures were necessary to secure a proper knowledge of the strains on railroad bridges throughout the State, and of the ability of the bridges to support them. A circular was then issued by the Board requiring railroad companies to submit strain-sheets of their bridges, and when these were received they were submitted to the inspection of Mr. Stowell as Engineer.

As there are about 2,500 railroad bridges in the State, the work to be done was very great, and it is not at all strange that several years have been occupied in doing it. That it has been thoroughly done the volume before us is evidence, containing as it does 1,876 pages closely filled with diagrams and tables.

The effect of this examination has been excellent, as is shown by the following paragraph from the preface:

> The result has been that managers found weak places in many of their bridges, of which they had had no idea. The mere fact that a strain-sheet had to be calculated by some one competent to do so brought to their attention defects, of which they might have remained in ignorance until awakened by a disastrous accident. In many cases the bridges were strengthened before the drawings and strain-sheets were sent to the office of the Board.

The Railroad Commission has made it a practice, when any defect is discovered, to notify the railroad company at once and require the bridge to be rebuilt or strengthened. There can be no doubt that this work has added substantially to the safety of railroad travel in the State.

ELECTRICITY AND ITS RECENT APPLICATIONS. By Edward Trevert. (The D. Van Nostrand Company, New York; illustrated, 350 pages.)

This is intended to be a practical book for students and for amateurs rather than a profound scientific treatise. It describes the later developments in electrical work in a way which can easily be understood by those who are not thoroughly versed in the science, and has more especial reference to the practical applications of electricity than to any theory in relation to it.

Among the subjects treated are Batteries; Dynamos; Field Magnets; Armatures; Telegraph and Telephone; Arc Lights; Incandescent Lights; Motors; Electric Railroads; Electric Mining Apparatus; Electric Welding; and a variety of others of less importance.

An appendix contains tables of electric measurements and a dictionary of terms used by electricians. The latter will be very convenient, especially to the general reader who wants to acquire some knowledge of electrical work, and to this class the book will be very acceptable. It contains much information, conveyed in a way which makes it possible to read it without having any extended knowledge of scientific electricity.

The book is fully illustrated, and the engravings are generally good, though a few have been admitted which are not up to the standard of the books. These are exceptions, however, and most of the cuts are good. The book will be found very useful for those who wish such a general understanding of the subject as will enable them to speak of it with some knowledge. For students also it is an excellent work.

GEOLOGICAL SURVEY OF NEW JERSEY. *Annual Report.* By John C. Smock, *State Geologist.* Trenton, N. J.; State Printers.

The work so well begun by the late Professor Cook is being steadily carried forward to completion under his successor. The Geological Survey proper is nearly completed, it is true, but much other work in connection with it is still to be done. The special reports on the geology of the northeastern section of the State, and on the Iron Mines, are among the subjects treated in the present volume.

Two important studies are now in progress, one being on the Water Supply and Water Powers of the State, including the kindred subjects of Drainage and Artesian Wells. The other is the preparation of maps showing the structural geology and the nature of the overlying soils. The first will show the rock formations, irrespective of the surface; the second will be properly an agricultural map, and will show the nature of the soils, their distribution, the outcrops, etc.

Special reports in the present volume are on the Geodetic Survey; on the Terrace Formations of the Atlantic Coast; on Water Supply and Water Power, and on Drainage. There are also valuable papers on the Iron Mines and on the Limestone Formations of Sussex County.

The Geological Survey of New Jersey has done thorough and excellent work, and the examination of water supply will add to the value which its studies have had for the State. It has been in good hands from the beginning, and in many respects might well serve as a model for other States. Its publications are an example of this; and almost the only fault that can be found with them is that they are too modest in their statements, leaving the importance of the work accomplished to be inferred rather than directly stating it.

TRADE CATALOGUES.

Construction and Use of Universal and Plain Grinding Machines, Cylindrical and Conical Surfaces, as made by the Brown & Sharpe Manufacturing Company, Providence, R. I.

This book contains a brief general introduction on grinding machinery; an illustrated description of a number of special machines made by the company, and finally a chapter on the care and use of the tools described. This makes it somewhat more than a mere catalogue, for it contains many useful hints and much information that will be of value to the foreman and shop owner.

The reputation of the company is such and the character of the tools it manufactures is so generally known that it is hardly necessary to speak of them here, except to say that the list contains a number of machines adapted to special work of various kinds, as well as to general work.

Hewlings' Directory of Steam Specialities and Engineering Appliances. Published by A. J. Hewlings, Chicago.

This book is intended to give as complete a catalogue of manufacturers of steam specialties as can be compiled, and the publisher has collected a large number of names of persons engaged in that line of business. There are also a large number of advertisements, every other page being given up to them, so that the book is quite convenient for reference to those in the trade, or to those who have occasion to buy steam fittings and appliances, as almost every one in business has to do now.

BOOKS RECEIVED.

Engineering Association of the South: Selections from Papers Presented during the First Fiscal Year, November 21, 1889, *to November* 13, 1890. Nashville, Tenn.; printed for the Association. This contains the more important papers read before the Engineering Association of the South last year, including an illustrated description of the Louisville & Jeffersonville Bridge, an account of the Natchez Water Works, and several others.

Report on the Internal Commerce of the United States for the Year 1890. *Part II of Commerce and Navigation.* By S. G. Brock, Chief of the Bureau of Statistics, Treasury Department. Washington; Government Printing Office.

What is Forestry? By B. E. Fernow, Chief of the Division of Forestry, Department of Agriculture. Washington; Government Printing Office.

Washington and Lee University: Catalogue, 1890–91, *and Announcements,* 1891–92. Lexington, Va.; issued by the University.

Report of the Director and Treasurer of the Michigan Mining School. Houghton, Mich.; issued by the School.

Reports of the Consuls of the United States to the Department of State. No. 128, *May,* 1891. Washington; Government Printing Office.

Statistical Abstract of the United States, 1890; *Thirteenth Number. Finance, Coinage, Commerce, Immigration, Shipping, Postal Service, Railroads, Agriculture, etc. Prepared by the Bureau of Statistics under the direction of the Secretary of the Treasury.* Washington; Government Printing Office.

Car Lubrication. By W. E. Hall, M.E. New York; John Wiley & Sons (price $1). This book is received too late for review in the present number.

The Hawkeye: Junior Annual of the Class of '92, *State University of Iowa.* Iowa City, Iowa; published by the Class. This is the yearly book representing the Iowa University from the students' point of view, and gives many interesting details concerning that institution.

Catalogue of the Pratt Institute, 1891-92. Brooklyn, N. Y.; published by the Institute.

Annual Report of the Bureau of Steam Engineering to the Secretary of the Navy. George W. Melville, Engineer-in-Chief, U.S.N. Washington; Government Printing Office.

TECHNICAL SCHOOLS.

THAT there is a growing demand for technical rather than general schools is shown by the increase in the number of students in existing technical schools, and by the increase also in the number of those institutions and in the appliances provided by them for the student. A general training no longer suffices to fit the student for work; engineering now includes so wide a range of work that it is necessarily becoming every year more subdivided and specialized, and some, at least, of the schools are recognizing this fact and making their arrangements accordingly, as is shown by several catalogues and other documents lately received, and now before us.

The University of Illinois, at Champaign, last year had 184 students in the engineering classes, of whom 95 were studying civil engineering; 78 mechanical, 5 mining, and 1 electrical engineering. In addition it had 73 students in the closely allied branch of architecture. These together made up about one-half of the whole number of students. In the several courses laid down an effort has been made to combine as much practical work as the time will allow, with the necessary theoretical instruction which is the basis of the whole. The instructors include Professors Ira O. Baker (Civil Engineering), Arthur N. Talbot (Municipal Engineering), and Arthur T. Woods (Mechanical Engineering).

Another Western institution which attracts many students of engineering is Purdue University, at Lafayette, Ind. Under

Professors Goss, Phillips, Creighton and others much improvement has been made in the courses and methods of instruction, besides additions to the plant. The civil engineering department has a fair equipment, and there is a large and well-supplied mechanical laboratory where experimental work can be carried on, and where practical instruction in forge and foundry work, iron fitting and woodwork can be given.

To a certain extent it is true that school instruction can never take the place of actual work in the shop, but it may be an excellent preparation for the student, and help him by showing how the theoretical knowledge he obtains can best be applied in practice.

The standing of Sibley College, the engineering department of Cornell University, has long been known, and it is only necessary to say that under Professor Thurston and his colleagues large additions have been made to the plant both for mechanical and electrical work. Last year over 450 students were enrolled there.

The University of Pennsylvania is now making additions to its buildings in West Philadelphia, with a special view to enlarging the department of mechanical engineering. A new building 80 × 45 ft. is being put up for this purpose. In the basement will be placed the engines and dynamos which supply light to all the buildings, and these will also serve as part of the plant used in instruction. The upper floors will contain workshops, drawing-rooms, and recitation-rooms. This will form a great improvement and addition to this department of the University, hitherto cramped in its operation by want of room and proper appliances. The special engineering library has been very much enlarged, though additions are still needed; these will be made as fast as circumstances will permit.

A school of Civil Engineering is maintained by Washington and Lee University, at Lexington, Va.; it is under charge of Professor David C. Humphreys, C.E., and is intended more especially to give the student such a theoretical training as will fit him to undertake the practical work of his profession, with a full understanding of its general principles, thus preparing him to learn more readily the application in the field of those principles.

ABOUT BOOKS AND PERIODICALS.

A LONG illustrated article on the California Lakes, by Charles H. Shinn, is the principal paper in the OVERLAND MONTHLY for July. Another article describes a visit to Crater Lake in Southern Oregon. The number is, indeed, largely given up to traveling sketches, for Texas and Western Australia furnish material for two other papers. The United States Military Academy at West Point is described by Edgar S. Holden, and an excellent variety of stories and sketches completes the contents.

The JOURNAL of the Military Service Institution for July has for its leading article Artillery in the Rebellion, by General Tidball. Other papers are on the Evolution of Hospitals, by Major Winne; Centralization in Army Affairs, by Colonel Lee; The Summary Court, by R. McK. Powers; Range and Position Finding, by Captain Zalinski; Military Penology, by Captain Pope, and a Chapter of American History, by Captain Ebstein. There are also discussions of several papers, and a variety of translations.

The latest number of the PROCEEDINGS of the United States Naval Institute has for its leading article the Disposition and Employment of the Fleet, by Lieutenant R. C. Smith. Naval Constructor D. W. Taylor gives a new method for calculating the Stability of Ships; Commander F. M. Barber writes of High Explosives in Warfare; Ensign A. P. Niblack describes a proposed system of signals, and Mr. Everett P. Hayden, of the Hydrographic Office, has a very interesting article on the Samoan Hurricane of March, 1889. There is also a discussion of the prize essay for 1891, besides professional notes and other minor matter.

Perhaps the most important paper in the ARENA for July is that on National Control of Railroads, by C. Wood Davis. In the other articles, Plutocracy, Neglected Crimes, the Swiss Constitution, and Theological Thought are among the subjects discussed. This magazine covers a very wide field, and covers it well.

The military article in OUTING for July continues the account of the Massachusetts Militia. There are, besides, articles on Fishing in New Mexico and in Ireland; on Tennis, Polo, Lacrosse, and other athletic games; a historical sketch of Bicycling, and some interesting notes of travel. The number has an unusual variety of illustrations.

In the ECLECTIC MAGAZINE for July there are given articles on the Warfare of the Future, from the *Nineteenth Century*; the Enormous Antiquity of the East, by Max Müller, also from the *Nineteenth Century*; Dust, from *Longman's Magazine*; Ideals of Art, from the *New Review*; and a variety of others from different English magazines and reviews.

In the POPULAR SCIENCE MONTHLY for August the Value of Statistics will be discussed by Hon. Carroll D. Wright, who is a master of the question. The Evolution of the Woolen Manufacture will be concluded, and Dr. Andrew D. White will discuss the epidemics of the past in an article styled From Fetich to Hygiene. There are several other articles of special interest.

The latest number of the NATIONAL GEOGRAPHIC MAGAZINE is devoted to Mr. Israel C. Russell's report to the National Geographic Society on his Expedition to Mount St. Elias in Alaska. It is illustrated by maps and photographs, and contains a great deal of information about the hitherto almost unknown regions of Alaska.

In the August number of HARPER'S MAGAZINE Colonel T. A. Dodge concludes his paper on Some American Riders. The historical papers on London are continued. An illustrated article on New Zealand gives an excellent general idea of that country and its abundant natural resources. Mr. Montgomery Schuyler gives some Glimpses of Western Architecture, the city of Chicago furnishing the text for his present paper. There is, besides, a great variety of lighter articles, stories and sketches.

The August number of SCRIBNER'S MAGAZINE is a "fiction number," chiefly devoted to short stories. There is, however, an article, in the Street Series, on Piccadilly, the great street of London, and one on the new Parliament of Japan.

That excellent paper, the AMERICAN MANUFACTURER AND IRON WORLD, of Pittsburgh, appeared on July 4 in a new dress, and at the same time abandoned its former large sheet, adopting a page about the size of that of the JOURNAL. The *Manufacturer* has always been readable and reliable, and in its new form is much more convenient and attractive than before. It should continue to enjoy the prosperity and influence which it has well earned.

The July number of BELFORD'S MAGAZINE is a very good one; so much so that it would be hard to specify any particular article as the leading one. There is no lack of the more serious and controversial articles for which this periodical is making a reputation; while the summer reader who looks merely for amusement will find lighter matter enough to satisfy his or her wishes.

In GOLDTHWAITE'S GEOGRAPHICAL MAGAZINE for July there is an article by Mr. C. DeKalb, which gives an excellent condensed account of the railroad systems of South America, their past growth and future prospects. Among other articles of interest are Geographical Progress in England; Tea Planting

in Ceylon; the City of Toronto; Completing the Exploration of Australia, and the Cañons of the Colorado. This magazine contains much that is of interest not only to the student, but also to the business man and the general reader.

THE UTILIZATION OF NIAGARA FALLS.

(Condensed from a lecture delivered by Mr. Coleman Sellers before the Franklin Institute, Philadelphia; published in the *Journal* of the Institute.)

THE extent of the area supplying water to the Falls of Niagara is so well known in a general way that it is only necessary to say that the drainage basin includes an area of over 240,000 square miles. The Falls are 23 miles below Lake Erie and 14½ miles above Lake Ontario. The total difference between the water levels of the two lakes is 326 ft., which is distributed as follows: Rapids between Lewiston and the lower Suspension Bridge, 100 ft.; rapids between the Bridge and the Falls, 10 ft.; the Falls of Niagara, 160 ft.; rapids immediately above the Falls, 50 ft.; Upper Niagara River, 6 ft. The extreme limit of variation in the depth of the river above the Falls is 3½ ft., but the limit is very rarely reached. Generally a variation of 1 ft. above the Falls is followed by a change of 5 ft. below. These changes are of short duration, and are generally due to long continued violent winds or sudden accumulations of ice. The average discharge of water from Lake Erie into the Niagara River is estimated at 265,000 cu. ft. per second. The flow is for all practical purposes unlimited and never failing.

The plan which is now being worked out by the Cataract Construction Company was originally suggested by Mr. Thomas Evershed, and when taken up by the Company was referred to Mr. Coleman Sellers as Consulting Engineer. Under his charge, and under that of Mr. Adams, the President of the Company, a commission was formed consisting of Sir William Thomson, of London; Mr. Sellers; Colonel Turrettini, a distinguished Swiss hydraulic engineer; Professor C. E. Mascart, of Paris, and with Professor W. C. Unwin, of London, as Secretary. This Commission asked for plans for the generation of power by turbines or other water moters, and for the transmission of power so generated. A large number of these were received and carefully considered. The whole were based on the work which the Company has already begun, and which is stated as follows:

The Niagara River above the Falls flows from the east to the west, and at the Falls the lower gorge, into which the water is carried by the two great Falls, the American and the Horseshoe, runs almost due north toward the west end of Lake Ontario. Between the line of the New York Central Railroad, as it enters the town of Niagara and the river bank is a strip of land averaging sufficient width to permit the laying out of a manufacturing town as an extension of the town of Niagara, with room sufficient to permit a long canal from the river to run parallel with the railroad, to enter the river below Grass Island with a diverging mouth of sufficient width to, of itself at its lower end, give water at the Central Station to the whole amount required if need be.

Streets are being laid out above Port Dey, where the existing hydraulic canal takes its water, for the location of mill sites, while farther up the river a large area of land, in all about 1,400 acres, will be reserved for dwellings of the operatives in conjunction with other large areas not owned by the Niagara Power Company, but being worked in harmony with it.

A tunnel requiring about 490 sq. ft. of rock excavation is being driven from above Port Dey on the land of the Company under the town of Niagara to a few feet below the Upper Suspension Bridge, a total length of 6,700 ft., to be extended up stream farther as required when the mill sites may be occupied. Only the lower end of the surface canal, as designed to feed the wheels that are to discharge into the tunnel, will be at present built, as from this point all the business will be allowed to grow upon the lines presently to be pointed out to you.

The tunnel will pass under the existing hydraulic canal that feeds the mills, which at present exist in the town of Niagara on the bank below the Falls. This canal has been in operation for about 40 years, and begins at Port Dey, at the immediate head of the Upper Rapids of the American Fall; Port Dey taking its name from one who was largely interested in the enterprise, and who has been noted for his connection with the manufacture of India-rubber in the United States. The canal passes through a reservation 100 ft. wide, but is only 35 ft. wide, and carries the water into a forebay parallel with the lower river, whence various factories are being fed. The whole amount of water that this canal will deliver is already exhausted so far as the power it is capable of yielding is concerned, with at present an operating efficiency of about 6,000 H.P. This power may be increased to double the amount by utilizing all the available fall, but it cannot be increased beyond that without deepening or widening the existing canal.

It may be noted here, that the mills that are fed by this hydraulic canal have been conducted with profit to their owners, on account of the steadiness of the water-power and the many advantages offered by Niagara as a site for manufacturing operations, as well as the great railroad facilities that have been for a long time in existence.

The reason for adopting a tunnel for a tail-race and placing the mill sites above the Falls was that land for manufacturing purposes was not available along the lower river, and that public opinion is very much against placing factories on the banks of the Niagara to the detriment of its picturesque features. A large part of the land also belongs to the State of New York, and is used as a public park. Moreover, water cannot be carried by canals for use in water wheels at nearly so rapid a rate as the tail or waste water from the wheels can be distributed through the tunnel. In the canal the velocity cannot safely be made much over 3 ft. per second, while in the tunnel the water may be carried at as high a speed as 25 ft. per second, so that the dimensions of the tunnel for the waste water can be very much less than would be required for the canal.

In utilizing this power it has been decided that a certain amount will be sold for local mills which will control their own wheels and deliver water into the tunnel. Beyond this the power will be retained entirely under control of the Company, and the plans formed are as follows:

There will be a central station for the generation, first of about 5,000 H.P. by compressed air, another one of 5,000 H.P. by electricity, with the possible extension of either one of these to the amount of 100,000 H.P. added in units of 2,500 to 5,000 H.P. to either, one by one, in whichever direction proves the most profitable and is called for by manufacturers. The Company is anxious to do this work cautiously, economically and thoroughly and to avoid mistakes. With this intent the matter has been placed in the hands of a Board of Engineers, of which Coleman Sellers is now the Chairman, with Colonel Turrettini as foreign Consulting Engineer, and Mr. John Bogart, the State Engineer of New York, as Consultant with Mr. Sellers, Mr. Clemens Herschel, the Hydraulic Engineer of the Company, and Mr. Albert H. Porter, the grandson of the one who originally owned Niagara Falls, as the Resident Engineer of the Company at Niagara.

Since this address was delivered, Mr. George B. Burbank, C.E., has been made Resident Consulting Engineer at Niagara Falls.

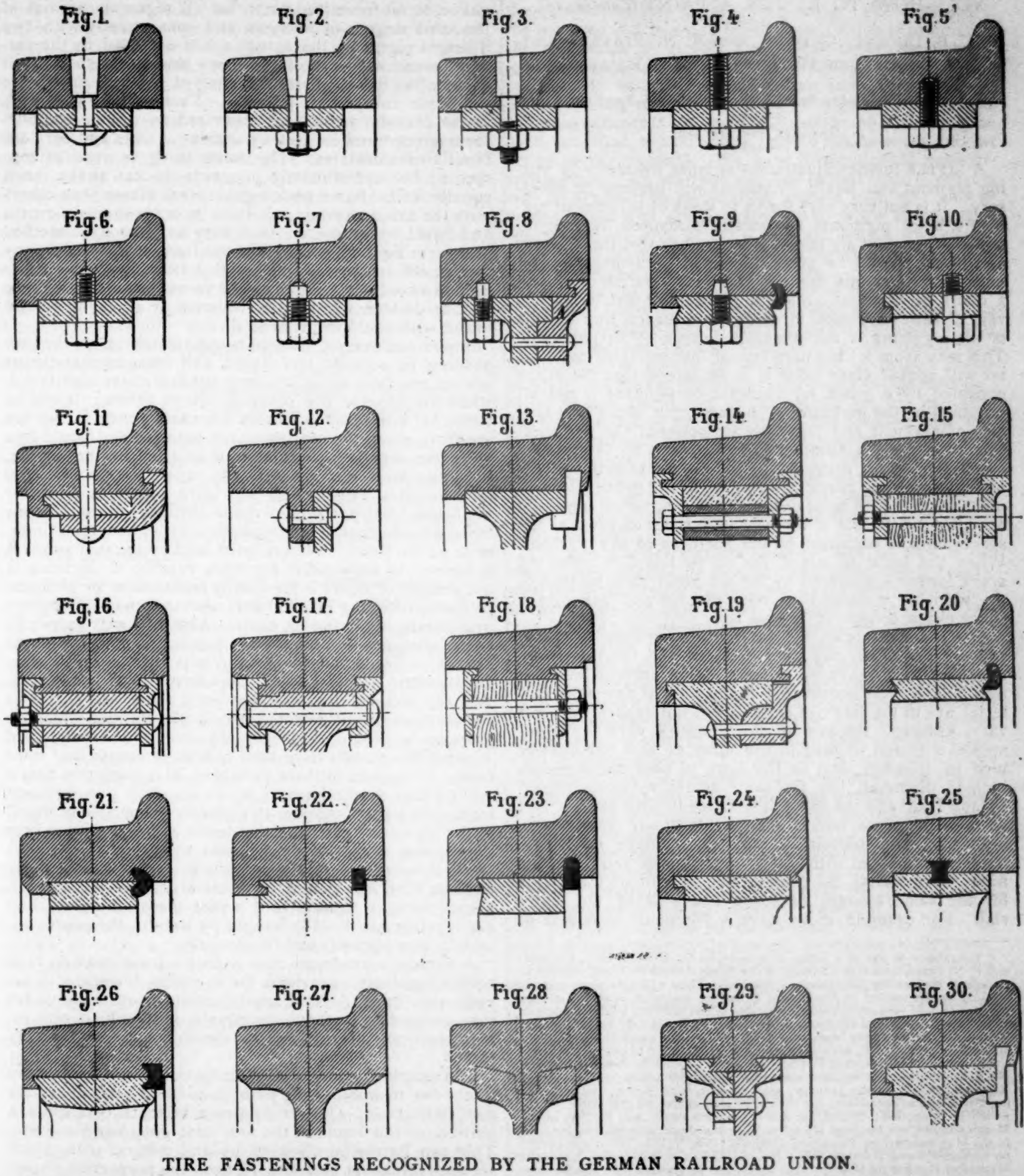
It is not probable that the whole amount of 120,000 H.P. will be used for a long time to come. It may be stated that the use of compressed air for the transmission of power has been adopted on account of the success attained with that method in Rome, in Paris, and elsewhere abroad, and it may be mentioned that this method has been used in several places where electrical transmission could not be conveniently applied. It is stated by the best authorities that 50,000 H.P. can by this method be carried 20 miles through two pipes each 26 in. in diameter, with a certainty that by increasing the pressure for the time being one pipe only might carry the entire amount, while the other one would be under repair. As to transmission by electricity, its capacity is already well known, and there seems to be practically no limit to the amount of power which can be conveyed in this way.

The work of the Cataract Construction Company is now being pushed rapidly, and Niagara is already being taken into consideration as a location for factories. A single firm has already leased 3,000 H.P. to be used for pulp mills and paper works, and the building of the factories is to be begun at once.

The lecture gives many other interesting particulars as to the transmission of power for long distances, and as to the methods which have been adopted for utilizing water powers in Switzerland and elsewhere.

GERMAN TIRE FASTENINGS.

At its meeting in October last the German Railroad Union decided that hereafter the statistics of breakages of tires should only be considered in cases where the types of fastenings applied were in use on at least 300 wheels. More recently the Union has published a plate showing



TIRE FASTENINGS RECOGNIZED BY THE GERMAN RAILROAD UNION.

the types of fastenings recognized; from this we have reproduced the accompanying plate, in which each figure shows one of the fastenings. No method, outside of the 30 shown, is accepted by the Union.

These 30 types are divided into two general groups, as described below, and each group is in turn divided into two classes. The drawings will explain themselves sufficiently without entering into a detailed description.

Group 1, which includes the fastenings shown in figs. 1–11 inclusive, covers all those types in which there is some weakening of the tire itself—that is, in which the tire has to be cut away or bored. In this Class 1, covering figs. 1–8, includes fastenings in which the pieces of a broken tire will not be held to the center; Class 2, in figs. 9–11, includes those in which broken tires will remain attached to the center.

Group 2, including the fastenings shown in figs. 12–30, covers all types in which there is no cutting, drilling or other weakening of the tire itself. The subdivision here is the same as in the other group. Class 1, represented in figs. 12 and 13, includes those types in which parts of a broken tire will be free to leave the wheel; Class 2, represented in figs. 14–30, includes types in which a tire will be held fast to the wheel-center, even when it is broken.

A study of these types of fastenings may show some new ideas, although most of them are not at all novel.

CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION.*

CHEMISTRY APPLIED TO RAILROADS.

XIX.—HOW TO DESIGN A PAINT (*Continued*).

BY C. B. DUDLEY, CHEMIST, AND F. N. PEASE, ASSISTANT CHEMIST, OF THE PENNSYLVANIA RAILROAD.

(*Continued from page 321.*)

A LITTLE further illustration of what we mean by mixing pigment and liquid by volume will perhaps be necessary. It is not very easy for us to think of volumes of pigments, since pigments are mostly measured by weight; and we do not at all mean, when we say that the pigment and liquid should be proportioned to each other by volume, that we should use, for example, a gallon of oil and a quart of pigment. Such a proceeding would lead to very disastrous results, for the simple reason that a quart of all pigments is not the same volume of all pigments. This may seem a little paradoxical, but we think the matter will appear clear when it is explained that the space occupied by a quart, for example, of pigment is not all occupied by the particles of pigment, but partly by particles of pigment and partly by air between the particles. We have made a number of experiments on the relative amount of space occupied by the pigment itself and the air in between the particles of pigment, and to our astonishment we find with most ordinarily fine pigments the space occupied by the air is three or four times as great as the space actually occupied by the particles of the pigment. When the paint is mixed the oil or liquid occupies the space formerly occupied by the air, while each particle of the pigment maintains its own identity and occupies a space characteristic of its own size.

Our experiments on the relative proportions of actual space occupied by the solid material and the interspace occupied by air have led to some rather curious information. It is well known that if particles of any solid material are in the form of spheres, the interspace does not vary, although the size of the particles vary. For example, a pound of lead in the form of shot one-quarter inch in diameter, and in the form of shot one-sixteenth inch in diameter, has the same actual volume occupied by the lead and the same interspace in both cases. Not so with pigments, nor, if we may trust our experiments, with any solid material in any other shape which we have experimented with. Our experiments show that the finer the material the greater the amount of interspace for the same amount of space occupied by the material. For example, if we have a pound of carbonate of lime, and grind it moderately fine, there will be a certain volume of space filled by the lime particles and a certain interspace. If the same amount of material is made finer and finer, of course the space occupied by the solid particles of carbonate of lime itself will be the same in all cases; but the interspace increases, and increases rapidly as the material gets finer. This fact makes it clear why we cannot take, for example, a quart of pigment and a gallon of oil for mixed paint, for all pigments are not of the same degree of fineness, and consequently with two different pigments the actual space occupied by the pigment would not be the same if we should take a quart of each. But for the correct mixing of paint we must have the same volumes of pigment. Furthermore it is well known that dry substances measured by volume compact themselves more or less by shaking. Oats and corn are familiar illustrations. The same thing is true of pigments; but unfortunately pigments do not shake down equally well. Some pack a great deal closer than others with the same shaking; so that, in order to mix pigment and liquid by volume, we shall have to get at some method of measuring the pigment different from putting it into any convenient measure. Our law that two or more pigments can be mixed with liquid on the same formula by volume only holds true when equal volumes of all pigments are mixed with equal volumes of oil.

There are several circumstances which affect the proportions of pigment and liquid, and these circumstances lead to practical variations from the law above mentioned, when we come to the practical use of paints. It will be borne in mind that in all this discussion thus far we are speaking about the proportions of pigment and liquid that will give the best paint after it is dried on the surface, reserving for a later point in the article the discussion of how to get a paint which will work satisfactorily under the brush; but it will be perhaps advisable first to discuss these concomitant circumstances a little, and their influence on the paint. We are quite well aware that where it is desired to have paint dry more rapidly, an increase in the amount of liquid is frequently made use of by practical painters, resulting in a thinner coat, and thus varying the proportions of oil and pigment. Also it is well known by those who are familiar with pigments that the same amount of liquid cannot be used with different pigments, due to their nature and to their fineness or coarseness. We are inclined to think, however, there are only two variables which will seriously modify the formula which we propose to give. These are the cost of the paint, and whether the paint is to be used as first, or second and third coat. In regard to these variables, it is quite true that a paint mixed on the formula which we shall give will cost more than a paint mixed with a greater proportion of liquid to the pigment; and if parties desire a cheap paint, a very simple way is to add more liquid to the paint, and thus cause it to cover a great deal more surface. It is perfectly obvious that less weight of material will be put on each square foot or square yard under these conditions, and since paints are usually bought by weight, the paint containing less pigment will be cheaper.

A variation produced with a desire for cheapness is of course legitimate, provided the variation is done with the eyes wide open, and the modification of our formula for this purpose is perfectly legitimate, although, if our experiments are correct, not as durable a job will be obtained.

The second legitimate modification of the formula is, we think, due to whether the paint is used as first, or second and third coat. Our experiments indicate that quite a portion of the liquid of the first coat goes into the wood. This can hardly be obviated by any method with which we are familiar at present. If, now, the proportion of pigment and liquid on the first coat is such as will give the most durable paint, our experience indicates that the paint becomes difficult to spread on account of the absorption of the liquid by the wood, and also there is quite a tendency for the paint to become spotted, due to unequal absorption on different parts of the wooden surface. Some portions take up a great deal more of the liquid than other portions, and these portions being deprived of a greater portion of their liquid, have a different shade from the contiguous

* The above is one of a series of articles by Dr. C. B. Dudley, Chemist, and F. N. Pease, Assistant Chemist, of the Pennsylvania Railroad, who are in charge of the testing laboratory at Altoona. They will give summaries of original researches and of work done in testing materials in the laboratory referred to, and very complete specifications of the different kinds of material which are used on the road and which must be bought by the Company. These specifications have been prepared as the result of careful investigations, and will be given in full, with the reasons which have led to their adoption.

The articles will contain information which cannot be found elsewhere. No. I, in the JOURNAL for December, 1889, is on the Work of the Chemist on a Railroad; No. II, in the January, 1890, number, is on Tallow, describing its impurities and adulterations, and their injurious effects on the machinery to which it is applied; No. III, in the February number, and No. IV, in the March number, are on Lard Oil; No. V, in the April number, and No. VI, in the May number, on Petroleum Products; No. VII, in the June number, on Lubricants and Burning Oils; No. VIII, in the July number, on the Method of Purchasing Oils; No. IX, also in the July number, on Hot Box and Lubricating Greases; No. X, in the August number, on Battery Materials; No. XI, in the September number, on Paints; No. XII, in the October number, on the Working Qualities of Paint; No. XIII, in the December, 1890, number, on the Drying of Paint; No. XIV, in the February number, on the Covering Power of Pigments; No. XV, in the April number, on How to Design a Paint; No. XVI, in the May number, on Paint Specifications; No. XVII, in the June number, on the same subject, and No. XVIII, also in June, on the Livering of Paint; No. XIX, in the July number, on How to Design a Paint. These chapters will be followed by others on different kinds of railroad supplies. Managers, superintendents, purchasing agents and others will find these CONTRIBUTIONS TO PRACTICAL RAILROAD INFORMATION of special value in indicating the true character of the materials they must use and buy.

portion. We are quite well aware that it is customary among many painters to use half as much pigment for the same amount of liquid for the first coat as for the second coat; and we have no experiments which indicate that this rule is defective, and see no reason why it should not be followed. Of course no definite formula can be given, as different kinds of wood differ greatly in their power of absorption. Our thought is that it is always advisable to use as much pigment and as little liquid as possible; and until some practical cheap surfacer is obtained, to be used as first coat, which will fill the pores and form a good foundation for the paint, there will have to be more or less latitude allowed in the relative proportions of pigment and liquid for first coat.

We are now ready to consider the question of what should be the relative proportions by volume of pigment and liquid in a paint which will give the best possible results so far as our experiments go, after the paint is dried on the surface. We have made a large number of experiments to determine these relative proportions, but it will hardly be advisable to go into all the details of these experiments, nor to give the methods made use of, as it would prolong this article to an undue length. The principle which has guided us has been that it was desirable to have as much pigment as possible present as a means of protecting the oil. Our experiments have led us to the conclusion that the best proportions of pigment and liquid with all pigments is:

Liquid.............65 to 70 per cent. by volume.
Pigment...........35 to 30 per cent. by volume.

We repeat here, because we conceive it important, that these figures mean not necessarily the proportions of pigment and liquid in the paint mixed ready for spreading, but the proportions of pigment and liquid, which are left on the surface after the paint is dry. The directions, which we give below for practical use, actually lead to the following percentages:

Liquid................67.60 per cent. by volume.
Pigment..............32.40 per cent. by volume.

We think it is entirely probable that many practical men will think we have proportioned our paint altogether too high in pigment, and it is possible that a very much wider practical experience than we have had will change these figures somewhat; but we are confident that if paints can be obtained which will under all conditions work satisfactorily on these figures, the painting of the country in general will be very much more durable than it now is. The rule for use in daily practice, and which will probably enable manufacturers and master painters to get a very much better conception of the kind of paint made than the figures above is as follows:

Multiply the specific gravity of the pigment in the dry condition by four, and this will give the number of pounds of dry pigment which are required for a gallon of liquid.

In deciding on the liquid, it is safe to say that for practical purposes the volatile part of the japan can usually be ignored, as being small in amount, and with most of the good japans in the market the non-volatile part amounts to about one-third the volume. Furthermore the results will be close enough for practical work, provided the amount of japan used in the mixed paint is small, if both the japan and turpentine are ignored. This makes the rule exceedingly simple—namely:

For each gallon of oil used take as much pigment as four times the specific gravity of the pigment.

We give below a few samples of paint mixed in accordance with this rule:

One gallon of oil requires 26.40 lbs. of dry white lead.
One gallon of oil requires 21.20 lbs. of dry white zinc.
One gallon of oil requires 20 lbs. of Indian red.
One gallon of oil requires 12 lbs. of yellow ochre.
One gallon of oil requires 11.84 lbs. of umber.
One gallon of oil requires 10.40 lbs. of bone black.
One gallon of oil requires 9.20 lbs. of P. R. R. Freight-car Color.

The specific gravities of many of the paints are easily obtained from the books; but there is an exceedingly simple method by which the specific gravity can be obtained by practical experiments sufficiently close for the purposes of this work, as follows:

Take a 100 cubic centimeter graduated vessel and put into it say 80 cubic centimeters of alcohol. Then weigh 20 grams of the pigment to be tested, and pour it into the alcohol, stirring with a glass rod until the air bubbles have all escaped. Divide now 20 by the increase in the volume of the alcohol expressed in cubic centimeters, and the quotient will be the specific gravity. For example, if the increase is 8.70 cubic centimeters, which is practically the case with P. R. R. Freight-car Color, the specific gravity is 20 divided by 8 70, which equals 2.30. It is only essential, in using this method, that some liquid be used which has no solvent action on the pigment; and so far as our experiments go, alcohol, gasoline or ether may be used, provided, as said above, they do not have any solvent action on the pigment. We have found alcohol most advantageous. We are quite well aware that many pigments may be obtained in the market ground with oil; and to enable those who are accustomed to work at least with white lead, we give below a formula, which will enable this ground pigment to be mixed according to the proportions by volume given above—namely,

One gallon of oil requires 41.80 *lbs. of white lead paste.*

It will be observed that quite considerable oil has to be added to the white lead in order to give the proportions by volume that our formula requires. If we are correctly informed in regard to the practice of master house painters, we are confident they will object to this formula; so far as our knowledge goes, they do not use anything like the amount of white lead that this formula calls for. It will be remembered that we have allowed half as much pigment for the first coat, and we are confident that nothing like as good results are obtained, so far as durability is concerned, by the present practice of master painters, as would be obtained if the formula which we give above were followed.

The query arises whether it would not be well if the trade would change its practice and grind the pigments with the proportion of oil required by the rule given above, so that when the paints were obtained in the market, all that it would be necessary to do would be to add a little japan, and then turpentine enough for spreading, as will be explained below. We throw out the suggestion for what it is worth. We are aware that the custom of the trade is to grind the paste as stiff as possible—that is, with the least possible amount of oil. In general we have found this to be the custom in all cases—at least, where the pigment is more expensive than the oil. It does not always hold true where the pigment is less expensive than the oil. In these cases we have found the paint ground pretty thin. It is perhaps natural that this should be the case, since paints are usually sold by weight.

We cannot help feeling that it would be extremely desirable if the paints of the market were ground on some definite formula, which would enable the purchaser to know how much oil and pigment he would get; and for this purpose we know of no formula by which this is so well and easily done as the formula by volume given above.

The proportions of oil and white lead paste given above make a paint fairly ready for spreading, especially if about 5 per cent. of a rather thin japan is added. With most of the paints which we have examined, however, the formula by volumes given above will not give a paint ready for spreading, and for the purpose of spreading the paint it is necessary to add something to it to make it thinner.

The reasons why all paints are not ready for spreading when mixed by volumes is two or threefold. In some cases the liquid is more viscous than others. This is especially true when a very thick japan is used. Also with white lead, white zinc, umber, etc., the chemical action between the pigment and the oil forms a little soap which is more viscous than the oil itself. Furthermore, whether the pigment is coarse or fine makes a difference in the amount of liquid required to give a paint ready for spreading. The finer the paint, the more liquid is required, and finally it is sometimes desired to have a coat of paint dry quickly; and it is well known that a very thick coat dries slower than a thin one, so that it is essential, we think, to add for the purpose of spreading something which will

enable varying conditions to be met; and at the same time, if the paint is proportioned on the formula by volumes as given above, when the paint is on the surface and dry, we will have a uniformly valuable protection, so far as protection depends on the proportions of pigment and liquid. Our practice, and the one which we recommend, is to have all the pigments mixed with liquid by volumes, as above described, and then for the purpose of spreading to dilute with turpentine.

This raises the question of how much the paint shall be diluted, and what means there is of deciding that different kinds of paint and different buckets of the same paint are equally diluted. We have never known of any means of testing the relative dilution of paints except to add liquid to the paint until it drips off from the stick or brush used in the stirring in the way that experience has indicated is about right. We have been astonished at the uniformity with which those who are experienced in this line of work mix successive batches of paint; but all do not have experience, and there is, therefore, apparently the need of some means of testing to see whether paints are diluted to a uniform condition. We have made use of the following method: We had made a square plate of cast iron 1 in. thick, 12 in. square, dressed all over. One surface was grooved from top to bottom with circular grooves three-eighths inch broad and one-eighth inch deep, the distance between grooves being about one-half inch. This iron plate was set up at an angle of 45°, so that the grooves would run from top to bottom. Two cubic centimeters of the mixed paint is then put at the top of a groove, a two-cubic centimeter pipette cut off a little at the bottom, so as to give a larger aperture, being used for the purpose. The paint is ready for spreading when this amount of paint runs from one end of the plate to the other in about five minutes. The temperature has an influence, and the test should be made at a temperature at which the paint is to be spread. We are quite well aware that this is rather a crude device, but it is astonishing how well it serves the purpose. If the paint is a little too thick it will stop two or three inches from the end and refuse to go any farther. The addition of a small amount of turpentine will then change it so that it will run perhaps one-half inch farther; a little further addition will produce a still greater change, and by a little adjustment the material becomes the right thickness.

We have made a number of experiments on different kinds of paint, to see whether when paints were diluted ready for spreading equal volumes of paint would cover equal amounts of surface—that is to say, will a gallon of paint cover the same surface, provided it is diluted for spreading in the uniform way, whether the paint is white lead, white zinc, Indian red, bone black, etc. Our experiments seem to indicate two or three things rather interesting. First, the difference in different men in putting paint on is very considerable; and the thickness of the coat with different operators may vary from one to three—that is to say, one operator will put on three times as much paint as another; second, where the paint contains considerable turpentine, to dilute it ready for spreading, the tendency is, especially in warm weather, to use a little more paint than if there is a very small amount of turpentine. This is probably due to the fact that when a paint is spread the turpentine commences to evaporate rapidly, and in joining together contiguous portions, that which is already on becomes thick, and it requires more paint in order to make the brush slide over it and make the union; third, all paints, so far as our knowledge goes, containing considerable inert material spread easier and more uniformly than white lead and white zinc. These variables aside, a gallon of paint covers about the same surface irrespective of the kind of paint, provided they are all thinned to same standard.

In concluding this perhaps too long article, we may say that all our studies on paint indicate two or three things.

First, that the use of paints has been much too largely a question of individual preferences.

Second, there is very great lack of definite rules and methods of designing paints, and mixing and using them.

Third, the whole field needs very much more experiment and study than we have been able to give to it, and what has preceded in this series of articles is not regarded as final on the subject, but simply as a small contribution to our knowledge.

To put the ideas contained in the three articles on "How to Design a Paint," which is, to a certain extent, the culmination of our study, into definite shape, we would say as follows:

AS REGARDS PIGMENT.

First, if there is any pigment not too expensive, of the desired color, use this pigment, and add as much inert material as it will bear without interfering with the optical covering power, sulphate of lime being preferred as inert material.

Second, if white is desired, or if there is no pigment of the desired color, use a mixture of white lead and white zinc half and half by volume as a basis, add tinting material if necessary, and then as much inert material as the pigment will bear without interfering with the optical covering power.

Third, do not mix any pigments which have any chemical action between themselves in water solution, and do not add to any pigment inert material between which and the pigment there is any possible chemical reaction in water solution.

AS TO LIQUID.

First, raw linseed-oil is the best material which is at present available for the principal portion of paint liquid.

Second, good japan is a legitimate, and an essential constituent of mixed paint, in order to facilitate the drying. It should not be used in greater amount than 10 or 15 per cent.

Third, turpentine, both as a constituent of the japan, and also added separately in order to dilute ready for spreading, is a legitimate constituent of paints.

AS TO PROPORTIONS OF PIGMENT AND LIQUID.

First, all pigments may and should be mixed with the liquid, which forms binding material in the proportions of about 65 to 70 per cent. by volume of liquid, to 35 to 30 per cent. by volume of pigment.

Second, the weight of pigment per gallon of liquid which forms binding material is obtained by multiplying the specific gravity of the pigment by four.

Third, turpentine should be used to dilute the paints mixed as above, in order to prepare them for spreading.

It would be extremely desirable to continue this series of articles on paints to cover a number of other paints which have not yet been touched, notably, japan, paints for iron work, etc. Our experiments, however, in these fields are hardly sufficient yet to warrant us in saying more on the subject at present. We are still studying the subject of paints, and possibly a little later will take up the question again.

In the next article we will take up some other materials, for which specifications have already been prepared.

(TO BE CONTINUED.)

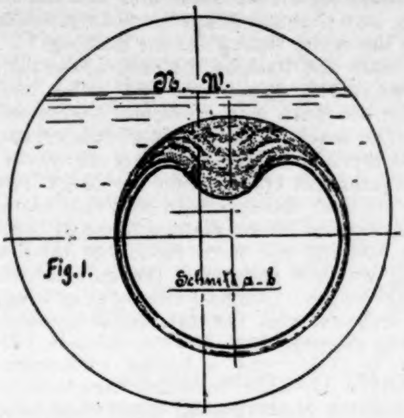
FAILURES OF CORRUGATED FIRE-BOXES.

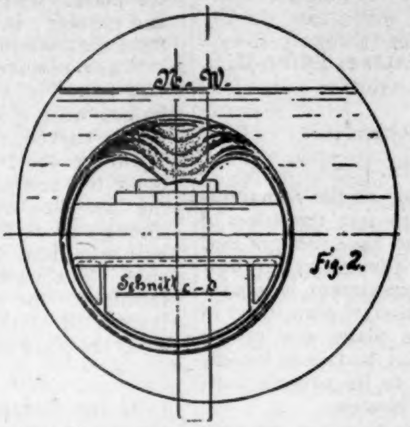
THE accompanying illustrations, from *Gläser's Annalen*, show a somewhat peculiar case of the failure of a corrugated fire-box. Fig. 1 is a section on the line *a b*, looking toward the forward end of the boiler; fig. 2 is a section on *c d*, looking to the back end; fig. 3 is a longitudinal section of the fire-box, showing the manner in which it collapsed. It will be seen that, without fracture, the surface of the corrugated fire-box was dented in and forced down until its lowest point rested on the fire-brick bridge.

The boiler was one of those in use at the pumping station of the water works at Essen-on-the-Ruhr, in Germany. The immediate cause of the failure was low water, the night fireman, who was in charge at the time, having allowed the water to fall considerably below the proper level. It is said that, from some unknown cause, he had formed the idea that the water level in the boiler was above that shown in the water-gauge, and had consequently allowed it to fall. The first intimation of danger which he recognized was when, in putting in coal, he noticed that the upper part of the furnace was red hot. He called the engineer, but before that officer came the collapse took place.

The figures show very well the peculiar form which the furnace assumed; they also show that the failure occurred directly over the bridge wall—that is, at the point where the roof of the furnace is subjected to the greatest heat.

The boiler in question was built in 1882, and was a cylinder boiler with internal fire-box. The boiler is 7 ft. 3

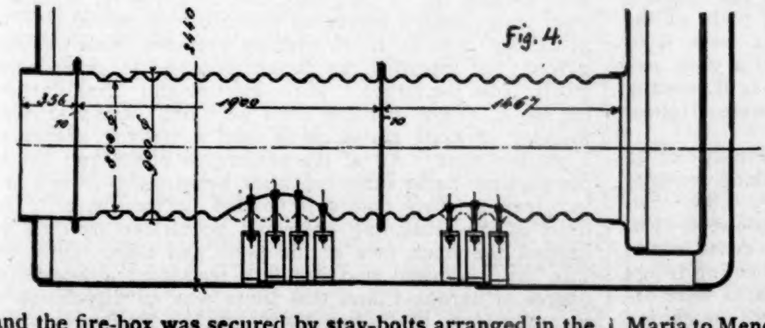


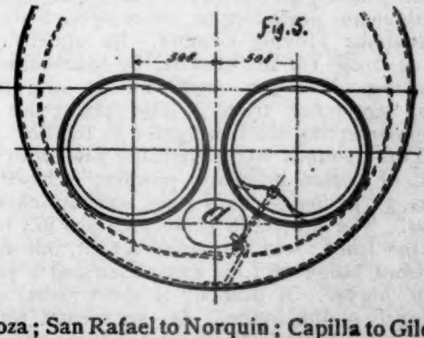


in. in diameter and 32 ft. 10 in. long. The corrugated tube forming the fire-box is 13 ft. 11 in. long, the grate extending about half the length; the diameter outside is 53 in., and inside 49 in.; the thickness of the plate being $\frac{7}{16}$ in. It was of the Fox pattern, and was made at the Schultz-Knaudt Works in Essen. Examination showed that the steel was of excellent quality, and in fact it was forced down into the bridge, making indentations in the hard fire-brick The boiler was licensed, after inspection, to carry a pressure of 90 lbs.; the usual working pressure was 75 lbs. In ordinary work the consumption of fuel was about 18 lbs. per square foot of grate per hour, and about $4\frac{1}{2}$ lbs. of water were vaporized per square foot of heating surface per hour.

No fault could be found with the material used; but it is possible that some better method of staying the furnace than that in use might have prevented a collapse.

In figs. 4 and 5 another case of partial collapse of a corrugated furnace is shown, with the means adopted for making temporary repairs. Fig. 4 is a horizontal section, and fig. 5 a cross-section. In this case the boiler was in use on the steamer *Kolomna* on the Caspian Sea. The water of this sea is very bad, and a thick deposit formed on the outside of the fire-box, which was probably the cause of the collapse. Deformations of the fire-box appeared in two places, as shown in fig. 4. The scale was so heavy that the man-hole *a*, fig. 5, could be broken open only with considerable difficulty. It was done, however,





and the fire-box was secured by stay-bolts arranged in the manner shown in the sketches, so that the boilers were continued in use and further collapse prevented.

In this case the deformations of the fire-box were on the lower side, the larger one being below the grate, and the smaller one behind the bridge-wall, so that they did not happen at the point where the heat was most intense, but at that where the scale was thickest.

ARGENTINE RAILROADS.

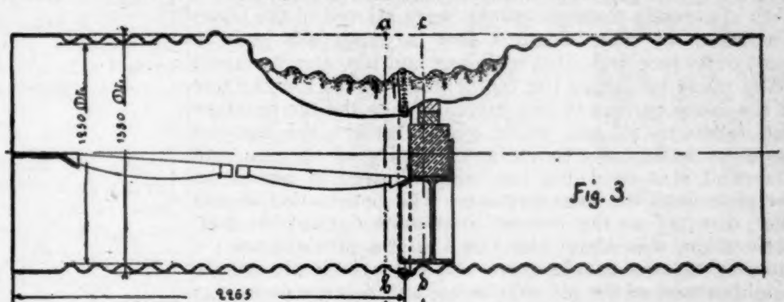
THE following statements are from the official report of the Secretary of the Interior of the Argentine Republic, which is dated May 1 last:

From January, 1890, till March 23, 1891, the following new railroads or sections have been opened to traffic:

1. Central Argentine branch from Cañada Gomez to Pergamino.
2. Buenos Ayres & Rosario prolongation from Pinto to Tucuman, besides branches to Santo Tome, etc.
3. Northwest Argentine from Caseros to Mercedes, and from Corrientes to Saladas.
4. Southern of Santa Fé to Venado Tuerto and Carlota.
5. Bahia Blanca Northwestern to Bernasconi.
6. Transandine, from Mendoza to Uspallata.
7. Great Northern, from Salta to Santa Rosa.

We have also approved the plans of the following:

1. Bahia Blanca to Ruffino, Pelleschi's concession, by way of Trenquelauquen, 353 miles, with a guarantee of 5 per cent. during 20 years on a cost of $12,600,000.
2. Mendoza to San Rafael, Bemberg's concession, with a 5 per cent. guarantee on $22,750,000.



3. Pilar to Campana, Meiggs's concession, without any guarantee.

We cancelled the following concessions: Parana to Tartagal; Villa Maria to Reconquista; Ituzaingo to Posadas; Buenos Ayres to Riachuelo; Chacari to Trenquelanquen; Rio Quinto to Rosario; Metropolitan Railroad; Zarate to Toay; Tigre to San Roque; Nuñez to Riachuelo; Villaguay to Colon; San Nicolas to Rufino; Catamarca to Buenos Ayres; Concordia to Concepcion; Villa Maria to Mendoza; San Rafael to Norquin; Capilla to Giles.

On January 1, 1891, there were 30 railroads in construction or survey with a total length of 12,600 kilos, or 7,800 miles, including four State railroads with a length of 440 miles, and 12 lines holding Government guarantees with a length of 4,030 miles, besides 19 others. In 1889 there were 5,150 miles of railroad open for traffic, and in March, 1891, no less than 7,310 miles.

The above lines employed 18,960 persons, and represented an outlay of $297,500,000. There were 11 of the above lines holding Government guarantees, amounting in all to $4,600,000 yearly.

RECENT EXPERIMENTS WITH ARMOR-PLATES.

By First Lieutenant Joseph M. Califf, Third U. S. Artillery.

(*Concluded from page* 317.)

FROZEN ARMOR PLATE.

An interesting experiment was made at the Annapolis Proving Ground, in November last, to test the effect of frost upon nickel armor-plate, as it had been thought that this metal might develop excessive brittleness at very low temperatures. In carrying out this experiment it was intended to fire three shots at the nickel-steel plate used in the September trials—one when the plate was at the normal temperature, a second after it had been frozen, and the third when it had returned to its original condition. Only the first two were fired, however.

The plate was mounted as before, only the distance from the gun was increased to 263 ft. The gun, the powder charge, the kind and weight of projectile were the same as in the previous trials. The first shot was fired with the temperature of the plate at 53°, and was directed on the central line to the left of the 8-in. perforation. After entering the plate 13½ in. and getting its nose into the backing, the projectile rebounded and was picked up 40 ft. from the target, somewhat cracked and slightly set up. Two apparently through cracks were started in the plate. To freeze the plate, a box a foot in depth was built in front of its face and filled with salt and ice, arrangements being made for taking the temperature at the top and one of the lower corners of the plate. When the temperature had fallen to 28° and would go no further, the box was cut away sufficiently to admit the aiming of the gun, and a second shot fired, the ice being allowed to remain on the plate until the last moment. The penetration of this shot, directed on the central line to the right of the 8-in. perforation, was about the same as the previous one; a number of new cracks were started, principally in the neighborhood of the old shot-holes, and a large piece was broken from across the top of the plate and thrown to the front. The projectile broke up badly, leaving its point in the backing. Except for the breaking up of the shot, there was nothing to indicate any additional hardness or brittleness in the plate on account of lowness of temperature. As this might well have been the fault of the projectile itself, it is understood that the conclusion reached by the Board was that the temperature reached had no appreciable effect upon the metal.

TRIAL OF A BETHLEHEM STEEL PLATE.

On January 20 last there was a trial of an experimental Bethlehem press-forged, oil-tempered steel plate at the Annapolis Proving Ground. Its dimensions were 6 ft. × 4½ ft. × 11½ in., secured by four bolts to a 36-in. oak backing. The gun used was the 6-in. B. L. R. used in the September trials. The projectiles were Holtzer armor-piercing shell, weighted to 100 lbs.

Three rounds were fired, the first with a charge of 48 lbs. of brown prismatic powder. The striking velocity was 2,032 foot-seconds; the striking energy 2,862 foot-tons. The projectile penetrated 12⅝ in., rebounded 25 ft. to the front; was shortened 0.1 in., but otherwise intact. A front bulge of 1 in. was raised and a projecting fringe ⅞ in. higher. A number of short radial cracks were developed in the bulge. At the second round the charge was increased to 48½ lbs., raising the striking velocity to 2,065 foot-seconds and the striking energy to 2,956 foot-tons. The projectile penetrated to a depth of 13 in., rebounded entire, 35 ft. to the front, and was shortened 0.1 in. A front bulge and fringe were raised, with short radial cracks, as in the preceding shot. The third shot was fired with the same charge as the second, and the velocities were assumed to be the same. The projectile penetrated a depth of 13⅝ in., rebounded 25 ft. to the front, and broke into two large pieces. A bulge of 1 in. and a projecting fringe of 2 in. was raised on the face of the plate. A through crack was developed from this shot hole to the bottom edge of the plate, and a fine surface crack from third to first shot-hole, and thence to top of the plate. The surface of all the shot-holes was smooth and regular; in the last shot star-shaped cracks extended from the bottom of the cavity through to the backing.

When removed from the backing the back of the plate was found in a remarkably good condition. The back bulges were a little less than 2 in. in height; were uniformly curved, with no cracks around their circumference. Upon the center of the first bulge there were no cracks; upon the second a faint hair crack, while the bulge from the last shot was cracked through. In addition to the through crack to the bottom of the plate, a fine hair crack half way from the bulge of the third to that of the first shot. The backing was not splintered, the indents conforming to the back bulges. A small fragment of fringe thrown off at the first shot was the only metal detached from the plate during the trial.

THE HARVEY TEMPERING PROCESS.

By the Harvey process of tempering armor-plate, it is the aim of the inventor to secure in one structure the good features of both the compound and the all-steel—that is, the extremely hard face of the one with the tough and elastic mild steel back of the other, without resorting to welding or the creation of any planes or lines of weakness.

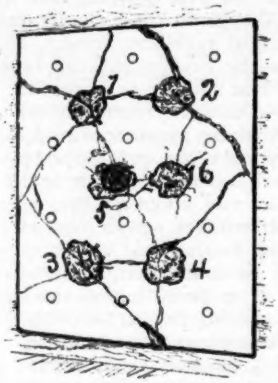


Fig. 6.

THE HARVEY PLATE AFTER TRIAL.

The face of the plate to be treated, which may be of ordinary mild steel or of nickel alloy, is, by a method of cementation, the details of which are not known, given a high temper and great hardness; this hardness gradually diminishing toward the interior, while the back of the plate retains the original qualities of the mild steel. This is the claim made by the inventor, and if true realizes what has been so long sought for in armor fabrication.

At the Naval Ordnance Proving Ground at Annapolis, on February 14, a trial was had of a 10½ in. Schneider steel plate, treated according to the Harvey process. The 35-caliber, 6-in. B. L. R. used in previous trials was employed, but mounted, as in the frozen-plate experiment, 263 ft. from the target. Three Holtzer and three Carpenter 100-lb. armor-piercing shell were fired with a striking velocity of 2,065 foot-seconds, and a striking energy of 2,988 foot-tons. All of the projectiles broke up; five of the six were badly shattered after penetrating from 4 to 5 in., leaving their points imbedded in the plate. The head of the remaining projectile penetrated nearly 5 in. beyond the back face of the plate and there remained. The result showed that the face possessed a wonderful degree of hardness, and that there was no disposition to separate from the softer back, but the plate was badly cracked through its entire thickness, although no part of it had fallen from its backing. Fig. 6 shows the appearance of the plate at the end of the trial.

To further test the merits of the Harvey process, a three days' trial was completed at the Naval Proving Grounds on May 8. Five armor plates each 8 ft. × 6 ft. × 3 in. were made especially for this trial by Carnegie, Phipps & Company, of Pittsburgh. One of untreated simple steel,

two of untreated nickel steel—one of low and one of high carbon—and one each of simple and of nickel steel treated by the Harvey process. Twenty-one shots were fired at each plate from a 6-pdr. Hotchkiss rapid-fire gun, using forged steel, armor-piercing projectiles with a striking velocity of 1,800 foot-seconds; the striking energy being considerably greater than was necessary to pierce an ordinary 3-in. steel plate.

The report of this trial says that the untreated steel plate made the poorest showing—nearly all of the projectiles going through, and cracking it badly. The untreated nickel steel, of low carbon, was better, but several of the projectiles went through, while others rebounded and broke up. The untreated nickel-steel plate of higher carbon made a still better record, as it was not cracked, and the greatest penetration was only 3 in. All the projectiles, except one, rebounded and broke up. The Harvey-treated steel plate was considerably cracked, but there was little penetration, and many of the projectiles broke up on the surface. After the trial was over this plate broke into four pieces. The nickel-steel plate treated by the Harvey process was scarcely injured. One of the projectiles scored a penetration of about an inch; the others were shattered upon the surface. The injuries to this plate were insignificant, and confined to one slight crack and a burring up of the surface where the projectiles struck.

Much credit has been claimed in some directions for the behavior of an 8-in. Cammell compound plate in a trial held at Portsmouth in February last. The plate was one manufactured for an Argentine war-ship, and was attacked, at 30 ft. range, by three 100-lb. Palliser chilled iron projectiles. With a striking velocity of only 1,566 ft., the projectiles all went to pieces, with but slight indentations in the face of the plate. The utter worthlessness of chilled-iron projectiles against steel or steel-faced armor-plate has been so often demonstrated that one is at a loss to understand the object or value of this experiment.

CONCLUSIONS.

In reviewing these experiments one cannot but recognize the fact that the means for thoroughly testing the resisting power of armor-plates were never so good as now. To be able to bring to the trial ground projectiles that are almost indestructible, and ordnance of sufficiently high power to place the attack at a decided advantage, are conditions never before attained. To attack an armor-plate with a gun of insufficient power or with an inferior projectile can only give results that are misleading.

In the Annapolis trials the summary of the Board sets forth very clearly the relative merits of the plates tested. The merits of the nickel-steel were further demonstrated by the handsome manner it held up under the frozen armor experiment of two months later.

In the Ochta trial it is difficult to explain, in the light of that at Annapolis, the relative behavior of the plates. The presence of nickel in the *Schneider* plate was at first questioned, but that it did contain a small percentage of nickel seems to be conceded. That it failed to affect the resisting quality of the metal as at Annapolis is evident. This has been explained upon the two grounds that the quantity was insufficient, and that the low temperature prevailing at the time was detrimental to its resisting powers, although the freezing test at Annapolis did not clearly demonstrate the evil effects of cold upon this kind of armor-plate. The *Vickers'* plate, of hydraulic compressed steel, held together the best of the three, and an order for this armor-plate was given by the Russian Government upon the strength of this trial. It is also understood that an order for the armor for one of the new English battle-ships has been given Mr. Vickers. If so, it will be the first steel-armored ship in the British Navy. The *Brown* plate, unlike the compound plate at the Annapolis trial, showed through cracks, and was pretty badly broken up.

It is to be regretted that the *Wilson* plate could not have been tested by the side of the others. In the test that did take place a few days later it is claimed that it behaved better than either of them. It is intimated, however, but with what justice it is impossible to say, that a good part of the firing against this plate was with soft projectiles. At least it is known that on the day of the first trial it was difficult to find enough projectiles sufficiently hard for the firing. Perhaps it should be said that Schneider excuses the behavior of his plate by saying that it was made more than a year before the one used at Annapolis, while it is known that a test specimen of the *Brown* plate had shown that it was below standard, and that it was contemplated sending another to replace it, but this was not done. No excuses for the *Vickers* plate are on record. Altogether this trial is much less satisfactory than the one at Annapolis.

The experiment of January 20 is noteworthy, inasmuch as the plate tested was the first American steel plate of any considerable thickness to appear upon the trial ground. The showing it made was a remarkably good one. The plate was somewhat undermatched, owing to the fact that the gun was limited to a pressure of 15 tons. This reduced the striking energy nearly 100 foot-tons below that calculated upon to match the plate.

An examination of fig. 6 will show how well the plate treated by the Harvey process fulfilled its mission of keeping out projectiles. It is true that the plate is badly cracked, but no part was dislodged, and if upon the side of a ship, where it would have had the support of adjoining plates, it might have stood a great deal of additional punishment. The penetration of the fifth shot is explained by the Harvey people by the statement that the hardening process at this point was incomplete.

In connection with this matter of through cracking of armor-plates, a writer in the *Engineer* points out the mischievous results that have followed the insistence by the British naval authorities that, whatever other quality armor should or should not possess, there must be, under the impact of a projectile, no through cracking of the plates. He says:

> Originally, it is believed the problem put to our Sheffield makers by the naval authorities was to make minimum liability to through cracks a primary condition; the hardness displayed by steel was to be given, if possible, subject to this leading stipulation—namely, that the plates were on no account to break up and strip off the sides of our ships. . . . This condition may not have been altogether wrong at first, but it has long since become mischievous.

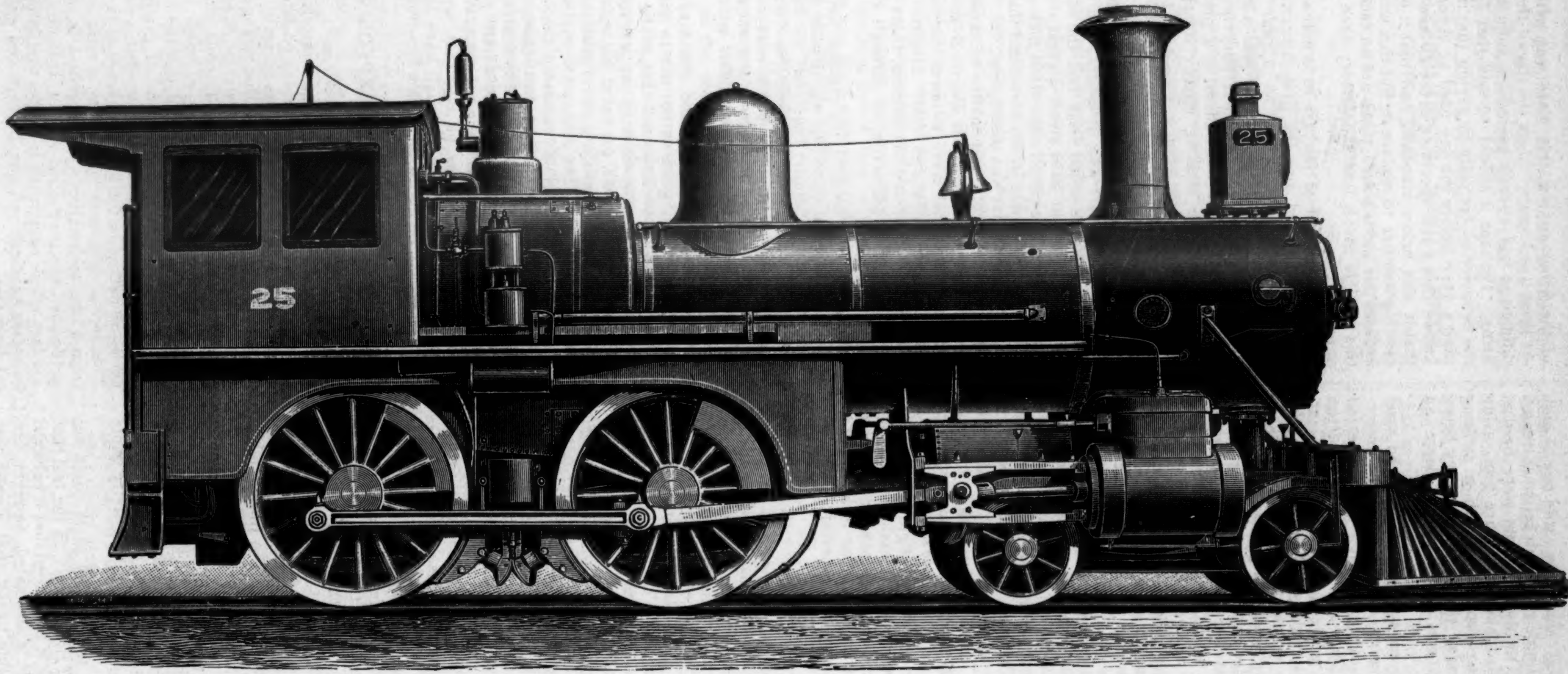
This, perhaps, explains what one may call the blind adherence of the English authorities to compound armor-plate—plate with backs so soft that, while through cracking is rare, its effective resisting depth is reduced one-half.

The ideal armor-plate, for naval use at least, is one that combines maximum resisting power with minimum weight—that is, thickness. The Annapolis trial seemed to show that the nickel-steel plate possessed the long-sought *desideratum*, hardness without brittleness. The Harvey process of tempering armor-plate indicates that it will yet be possible to effectively combine a hard projectile-resisting face with an elastic, tenacious back. When this anticipation is realized it may be said that, with our present knowledge of metallurgy, we shall have attained all that can reasonably be hoped for in this direction.

THE SAFE HIGH EXPLOSIVES.

(From the New York *Times*.)

THE heavy sentence of four years' imprisonment, in addition to fines, imposed the other day on four persons connected with the alleged sale of the secret of mélinite to the Armstrongs gives a new turn to that strange affair. It was recently announced by the Minister of War that M. Turpin, the inventor, and Captain Triponé, the agent of the Armstrongs, really had nothing of value to the French Government to negotiate for, and that the most important part of the invention—the means of exploding mélinite after it has been united with another substance in the shell—remained in the sole possession of the Government. This second substance is cresilite, a nitro-cresol obtained from a coal-tar product; and after two-thirds of the space in the shell has been filled with it, mélinite is rammed in—a fact which sufficiently indicates that both products can be safely handled, and can be exploded only by a powerful detonator.



PENNSYLVANIA RAILROAD STANDARD PASSENGER LOCOMOTIVE, CLASS P.

BUILT AT THE ALTOONA SHOPS. THEO. N. ELY, SUPERINTENDENT OF MOTIVE POWER.

This mélinite affair has naturally had an interest for all countries that are trying to solve the problem of securing a safe high explosive as the bursting charge of shells used in ordinary powder guns. It seems clear that Turpin made the original invention from which the official mélinite of to-day has been developed, and sold it to the English firm when the French Government was not satisfied with it. The English high explosive known as lyddite, which has been used for several years in experiments at Lydd, has always been spoken of as the invention of Turpin, and it is known to be largely picric acid, which is also the foundation of mélinite. The French were perfectly well aware that the English were using this substance, and that to that extent the secret of safe high explosives for military use was not within their keeping. Indeed, it has been said by good authority that nearly all high explosives for shells are either gun cotton or picric acid compounds. The original objection to the latter was that they were too susceptible to concussion, and would explode before that degree of penetration without which the effect of high explosives becomes of much less importance. But it is evident, from what has already been said, that mélinite does not explode by concussion alone, while the English are said to have pierced several inches of steel with a lyddite projectile before it exploded.

The main point of interest in the matter is that, while in our country attention has chiefly been given to the production of a safe propelling power for high explosive shells, as shown in the pneumatic tubes of the *Vesuvius*, the French have been making the high explosive itself safe for handling and use in ordinary powder guns. The charge of mélinite is not so great as that which can be used in a compressed air gun, but it has the enormous advantage of high velocity, long range and the accuracy and penetration which come of ordinary horizontal shell firing. In the 6-in. gun a shell weighing 121 lbs. has a bursting charge of about 23 lbs. of mélinite; and it is said that in some guns shells charged with 70 lbs. of mélinite have been repeatedly and safely fired with an initial velocity of 1,300 ft. per second.

But France is not alone in this quest. Lieutenant Southerland, of our Navy, in an official publication on the subject, mentions a large number of substances thus employed. One of these is écrasite, which has been adopted by Austria. It is supposed to be a composition of blasting gelatine treated with the sulphate or hydrochlorate of ammonia, is more powerful than dynamite, and is as absolutely safe to handle as mélinite itself. It has been made to penetrate a depth of 8 in. of iron without exploding. The same authority speaks of the Swedish extralite, which is believed to be a picric acid compound, and is also perfectly safe to handle, being exploded only by special means. The experiments with emmensite in our own country are well known, and other explosives have been tested by our naval authorities at Newport, among them being one called bellite. The main fact, that some safe high explosives for the bursting charges of projectiles do exist, seems to be beyond dispute. The mélinite incident in Paris will perhaps increase popular interest in a matter which is likely to be of much importance in the warfare of the future.

A PENNSYLVANIA RAILROAD PASSENGER LOCOMOTIVE.

THE accompanying illustration, taken from a photograph, shows the latest standard locomotive for general passenger service built by the Pennsylvania Railroad Company at its Altoona shops. This type of locomotive is called Class P by the company.

The boiler is built to carry 160 lbs. working pressure, and is 54 in. in diameter outside of the smallest ring. There are 210 tubes, 2 in. in diameter and 11 ft. 4 in. long. The fire-box is of the Belpaire type, and is 9 ft. 11⅝ in. long inside, 40 in. wide, and 50 in. deep in the center. The grate area is 33.26 sq. ft. The heating surface is: Fire-box, 141 sq. ft.; tubes, 1,246 sq. ft; total, 1,387 sq. ft. The smoke-stack is 18 in. inside diameter. The center of the boiler is 7 ft. 2¼ in. above the rail; the total height from the rails to the top of the smoke-stack is 15 ft.

The driving-wheels are 68 in. in diameter and are spaced 7 ft. 9 in. between centers. The total wheel-base of the engine is 22 ft. 8½ in. The rear driving-axle is under the fire-box. The driving-axles have journals 8 in. in diameter. The truck-wheels are 33 in. in diameter.

The cylinders are 18½ in. in diameter and 24 in. stroke. The valve-motion is of the ordinary shifting-link pattern. The throw of the eccentrics is 5 in.; the greatest travel of the valves is 5 in., and they have ⅞ in. outside lap. The steam-ports are 1¼ × 17½ in., and the exhaust-ports 2¼ × 17½ in. The exhaust nozzles are double, 2¾ × 3½ in. in size.

The tender is carried on two four-wheel trucks and the tank has a capacity of 3,000 gallons. The engine weighs 106,000 lbs. in working order, 65,150 lbs. being carried on the four driving-wheels and 40,850 lbs. on the truck. The weight on the drivers is thus about 8¼ tons per wheel.

THOUGHTS ON MARINE ENGINEERING.

BY ALOHA VIVARTTAS.

(*Concluded from page* 309.)

THE art or science of navigation as taught by Maskelyne, Norrie, Bowditch, Thom, and others consisted principally of rules and methods by means of which the seaman could find and keep the run of his position and desired course during long periods of time, in open sea, under varying conditions of winds, currents, and rates of speed; where generally ample time could be taken to work a "traverse" or post up and compute a "dead reckoning," and where the continual necessity for vigilance kept the captain and all hands *au fait* in the use of all the means aboard with which to accomplish the desired end; where the use of the lead line, not only to decide the actual depth of the water and probable location of the vessel at the time, but also to define the direction and amount of the current or drift when at anchor or becalmed, was never to be forgotten. In all of this the navigator was supposed to use his own head, and judge for himself the speed and leeway at all times; and if near land, no excuse was taken for neglect of any precaution by means of which he could increase his information on these points.

The development of the steamer capable of great and continuous speed has changed the meaning of the word navigation; the art and science has gradually dropped out of sight and out of mind.

The navigator takes a steamer out of port, with his course and speed fixed by rule or custom; the leeway or drift and currents he is to meet are accounted for.

Lights along the beach have multiplied. He rarely hears of a lead-line; the old song "By the deep nine, and a quarter less seven," etc., is a dead language to him; he works no traverse more difficult than getting around a horn or the contents thereof.

He feels no doubt about where he is at any time. He fears no premature approach to a dangerous coast. In fact, to him no coast is dangerous; it is the coaster he dreads and looks out for; like a man crossing a railroad track, his greatest danger is that of being run down.

And to such an extent is this fact recognized by the public and authorities that be, that when "slowed up" in a fog, if he use his whistle well he may drift ashore for want of his lead-line, like one of our finest Sound steamers; or to drift to leeward of his course in a stiff breeze and be wrecked on a well-known reef in clear weather, like another fine steamer; yet the navigator and all of his assistants be held blameless.

The old time navigator became most anxious and careful when near the coast where many vessels were to be met; but he had not nearly as many vessels to avoid then as are now found on the same ground, nor did any of them travel so fast as many of them do now.

The increase of their speed and the multiplication of the number of the vessels have made a collision the greatest and most to be dreaded danger of the sea to-day—until the

word "collision" has stepped out of the dictionaries into common use within the last fifty years, and has advanced in fear more than in favor, being now probably more used than any other when disasters are to be described. Num-

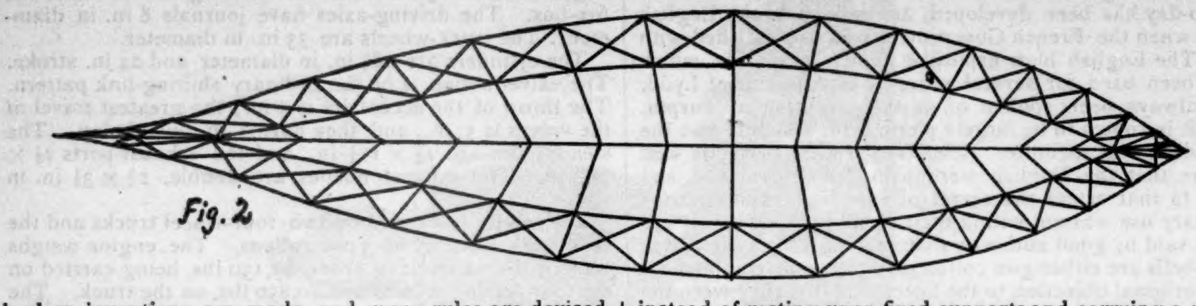


Fig. 2

berless inventions are made, and many rules are devised to prevent them; and while every possible care and effort should be made by those in charge to avoid collisions with other vessels, icebergs, rock, or beach, it is also incumbent

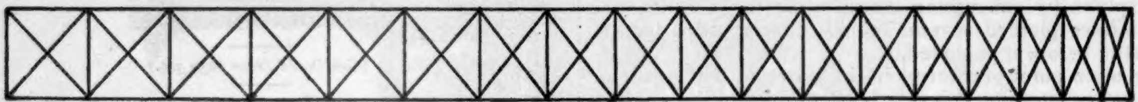


Fig. 3.

upon the engineer to so construct his vessel that in the collision which must be expected some time she shall suffer as little as possible.

And in this matter there are several things to be studied

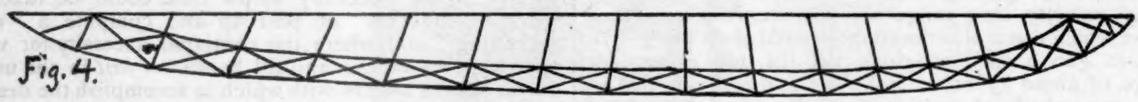


Fig. 4.

besides the old style ship. Thus, in the most common case, a collision between two vessels, the blow is generally given and received in a nearly level direction, and is to be best met by strength in the deck. The New York ferry-boat has struck the keynote in this. The deck is the ship *par excellence.* With a sound deck beneath his feet and above water, no seaman despairs; his masts may go by the board, his keel may drop out, but while he can keep his deck above water he feels safe.

A serious defect in ordinary construction, whether of

Fig. 5

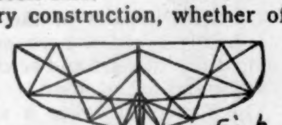
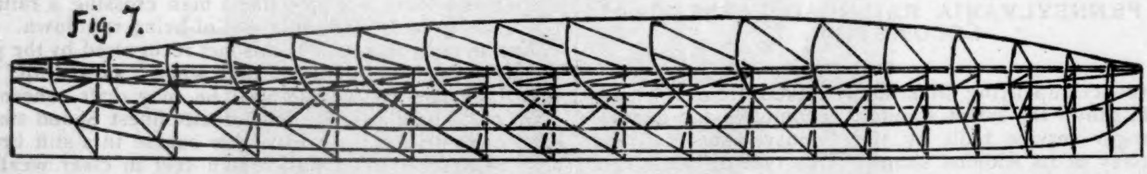


Fig. 6

wood or iron, is making the deck practically a rectangular structure with no diagonal bracing. *Nota bene:* "Hanging knees" are never struts, but only crooked fish-plates.

The engineer, recollecting that a blow from without will be most severely felt when received in a direct line toward the center of gravity of his vessel, will set his struts in position to take such blow "end on;" and inasmuch as the vessel is liable to receive such blow on any and every

Fig. 7.



point of her circumference, the radial truss of the generic form shown in fig. 2 results as the lightest and strongest form for resisting it.

Next to the danger of collision with other vessels is, perhaps, the danger of going upon the beach; and as this is a trouble which must sometime be endured—for the luckiest ship must sometime rest on hard bottom, if only on a dry-dock—the engineer will meet it by a longitudinal vertical truss through the center of his vessel (fig. 3); and in constructing such truss he will remember that while his bridges keep their perpendicular, and are calculated to resist an attraction of gravitation which acts invariably in a vertical direction, while the only side pressure to account for was the wind, he has now to make a structure which, instead of resting upon fixed supports and carrying a moving load, must carry a comparatively stationary load over moving supports, and many conditions are reversed. Yet he will not, like the old-style ship-builder, neglect his diagonal bracing. Verily, the buildings designed for South American railroads, in view of expected earthquakes, were better braced than are ships which fear nothing so much as a solid and stationary resting-place. But the engineer sees that his vessel must carry her load, although she will not always retain her perpendicular; and also, as from the variations of the levels of her supports, she will sometimes move in a more or less up-and-down direction, and hence is liable to strike a rock or iceberg at any angle from the level plane clear around to the vertical one, he will reinforce his deck and amidship trusses by a system of radiating longitudinal trusses (figs. 4 and 5), sustained by a system of vertical trusses (fig. 6), which will stand in vertical planes radial to the center of gravity of the whole, and therefore agree with the main struts of his deck.

The intersections of the planes of the various vertical and longitudinal trusses will be the positions of his main system of struts, which will, like those of the main deck, stand nearly radial to the general center of gravity, as shewn in fig. 7.

This leads the engineer to a kind of spheroidal style of framing, with truss work radiating in every direction, the parts sustaining each other and distributing strains by a corticulated system of members, while the exterior form of the submerged body will vary comparatively little from the smaller craft now in use. For as men have been building small boats for many years, but large ships only a shorter time, so the small boats are, even now, far better models than the larger ones; and many a ship goes to sea which is far less seaworthy than her long boat.

But while below the water-line the small boats are tolerably well shaped for their purpose, above the water-line the form may be varied at will; and there is no excuse for the defects which grow in a geometrical ratio as the boat increases in an arithmetical one.

It will be questioned if such construction will not fill up the hold of the vessel, and so lessen her carrying capacity.

But it is to be remembered that the carrying capacity of any vessel is not to be measured by the cubic contents of the empty space within her, but is only limited by the cubic contents of her outside bulk below the water-line or "displacement," so called because it is exactly equal to the weight of the bulk of water she displaces.

The old practice of building vessels to carry inside and below the level of the water surface as many cubic feet of clear space as possible in proportion to the cubic contents of the outside bulk, has led to the crustacean style of ship-building, and bred many a disaster. Nature tried the experiment ages ago ; and all of her large and powerful animals are vertebrate ; only a few crabs and lobsters carry their strength entirely upon the surface, like a modern ship. And to-day the term egg-shell is a synonym for weakness. Yet an egg-shell will not break, although falling several times its own diameter, and may ride the surf and come ashore in safety when the strongest ship afloat would be literally broken up, not by the force of the sea, but simply by her own weight, falling a distance less than one half her vertical dimension upon the beach as the sea slipped out from under her.

It is strange that with ages of experience, and many good old rules in various languages forbidding or advising against carrying the center of gravity of the vessel much, if any below the level of the water surface, men claiming some knowledge in sea matters persist in the dangerous practice of putting their weight as low as possible. And yachts with lead on their keels stagger about like men with wine in their heads, neither case being an indication of wisdom.

But if, then, the center of the weight should be kept well up to the level of the water-line, there is no objection to putting the needed strength below it. A dim idea of the fitness of this is floating about in the form of a "double bottom," which is sometimes made, but fails for want of the general truss principle—that is, struts to resist thrust and ties to carry tension. The ordinary iron or wooden ship has material enough in her to insure double her present strength if properly placed. How would our ocean piers stand if built of angle iron, with reverse bars, deck-beams, and outside plating, with internal bulkheads, like an ocean steamer?

The old sailing vessel exhibits a singular phenomenon in having started with a small hulk, which was constructed as a shell, and has been enlarged as a shell, with proportionate loss of strength. But in the matter of sails and rigging the small original started with spars to take thrust and ropes to bear tension, and without change of geometric principles bears enlarging to the needs of the biggest ship afloat, yet holds its strength in proportion to its size. Indeed, there are few, if any better studies in thrust and tension, resolution of forces and distribution of effects than a square-rigged ship properly handled under varying conditions of wind and sea.

An illustration of this is seen in the largest class of derricks as invented by A. D. Bishop, which, copying the geometry of the mast, yard, topping lift, and rolling tackle, by means of which sailors lift and swing their heavier weights, improved upon the details by stiffening the yard in a horizontal plane, increasing the number of topping-lifts, to be always ready for a strain at any point, and carrying the rolling tackle to the "chest trees," as it were, relieving the mast from a short cramp at the slings, without interfering with the side or horizontal swing, thus adapting the machine to the especial work of handling extraordinary heavy weights, without reference to the matter of carrying and handling sails, the primary object of the original mast and yard. These improvements are the improvements of an engineer, not a shipwright, and were first designed and used to handle the heavy stone in the construction of High Bridge over the Harlem River.

ORDNANCE NOTE.

THE accompanying table, which we reprint from the *Army and Navy Journal*, will be interesting as showing just what has been done by our Army and Navy ordnance authorities toward the armament of our forts and ships since the rehabilitation period commenced. It shows the number of guns and mortars that have been ordered and

UNITED STATES ARMY BREECH-LOADING RIFLED ORDNANCE, 1891.

Calibres.	Weight.	Tot. Length.	Length of Bore.	Charge.		Powder Pressure.	Initial Velocity.	Muzzle Energy.	No. of Guns, &c.	
				Powder.	Projectile.				Or'd.	Comp'd.
	Pounds.	Feet.	Calibres.	Pounds.	Pounds.	Tons, □"	Feet.	Ft.-tons.		
Mountain and Field Artillery.										
3-in. Mountain gun, steel	218	3.9	14.	0.88	12.	6.5	870.	63.	1	1
3.2-in. light field gun, steel	829	7.56	26.	3.75	13.5	15.	1675.	263.	100	75
3.6-in. field gun, steel	1181	7.56	23.	4.50	20.	16.	1554.	335.	1*	1
3.6-in. field mortar, steel	244	2.75	5.25	1.00	20.	8.	650.	58.	1†	1
Siege Artillery.										
5-in. guns, steel	3960	12.15	27.	12.50	45.	16.	1830.	1000.	11	1
7-in. howitzer, steel	3710	8.06	12.	9.75	105.	12.5	1085.	857.	11	1
Sea Coast Artillery.	Tons.									
8-in. gun, steel	14.5	23.21	32.	130.	300.	16.5	1935.	7787.	35	2
10-in. gun, steel	30.0	30.60	34.	256.	575.	16.5	1940.	15000.	34	1
12-in. gun, steel	52.0	36.66	34.	440.	1060.	16.5	1940.	26000.	26	—
12-in. mortar, cast-iron, steel-hooped	14.25	10.75	9.	80.	630.	12.5	1152.	5796.	74	1
12-in mortar, steel	13.0	11.76	10.	100.	800.	16.	1150.	7334.	1	—

UNITED STATES NAVAL BREECH-LOADING RIFLED GUNS, 1891.

Calibres.	Weight.	Tot. Length.	Length of Bore.	Powder.	Projectile.	Powder Pressure.	Initial Velocity.	Muzzle Energy.	Or'd.	Comp'd.
4-in. R. F., steel	1.5	13.7	40.	14.	33.		2000.	915.	35	4
5-in. R. F., steel	3.1	17.4	40.	30.	50.		2250.	1754.	27	—
5-in. Mark I, steel	2.8	13.5	30.	29.	60.		2000.	1664.	2	2
6-in. Mark II and III, steel	4.3	16.3	30.	50.	100.		2000.	2774.	125	107
6-in. (35 calibres) steel	5.2	18.8	35.	50.	100.		2080.	3000.	1	1
6-in. (40 calibres) steel	6.0	21.3	40.	50.	100.	15	2150.	3204.	2	—
8-in. Mark II, steel	13.0	21.5	30.	115.	250.		2000.	6934.	37	15‡
8-in. Mark III, steel	13.1	25.4	35.	115.	250.		2080.	7500.		
10-in. steel	25.7	27.4	30.	240.	500.		2000.	13870.	26	8
12-in. steel	45.2	36.8	35.	425.	850.		2100.	25985.	8	1
13-in. steel	60.5	40.0	35.	550.	1100.		2100.	31862.	12	—

* Orders for 24 guns await completion of tests of type gun.

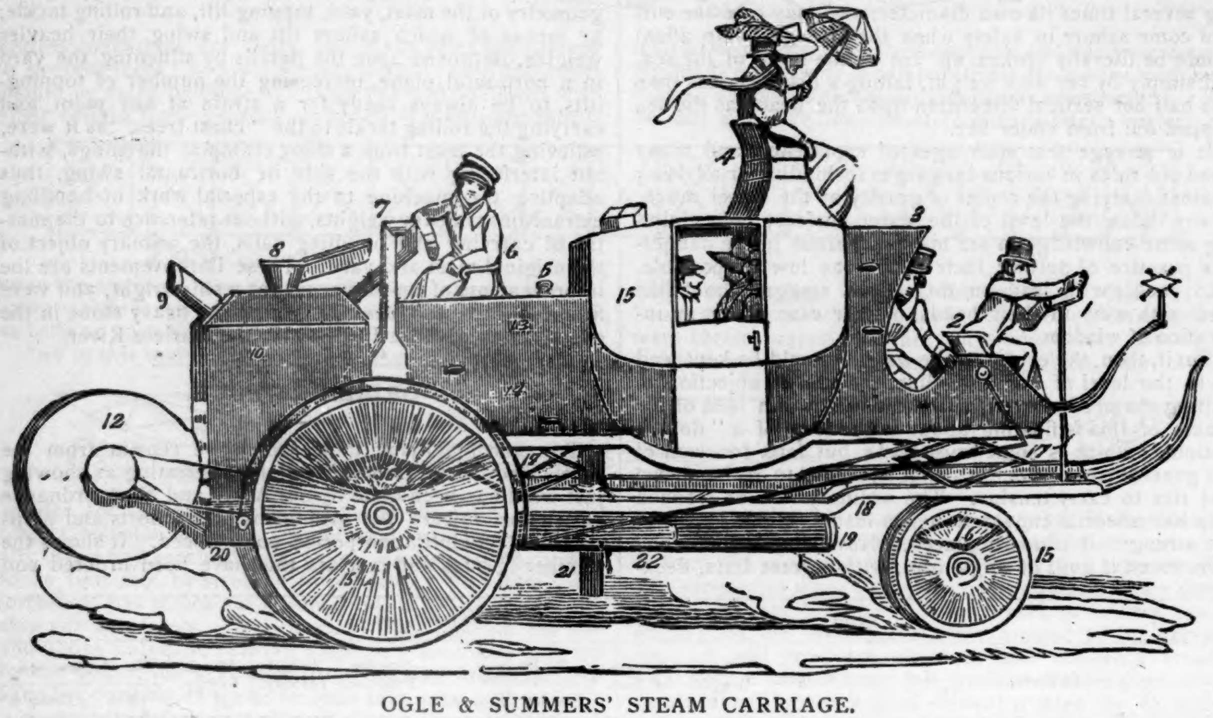
† Orders for 16 mortars await completion of tests of type mortar. 25 of the 8-in., 50 of the 10-in., and 25 of the 12-in. will be added to the above next month, when bids will be opened for their construction by private contract.

‡ Including six guns of Mark III. Two 8-in. guns of 40 calibres length have been designed.

completed to date. With the exception of a few 4-in. guns, the Navy Ordnance Bureau has ordered all the guns that are necessary for the armament of all the vessels thus far authorized by Congress.

STEAM CARRIAGES ON COMMON ROADS.

IN the June number of the JOURNAL, page 286, there was published an illustration of a steam carriage, invented and built in France by M. Serpollet, for use on common roads. In the description this was referred to as a revival of an old idea. Some correspondents having taken exception to this, we reproduce here, from our old files, two illustrations showing steam carriages, for their information and for the benefit of our readers generally as a bit of history.



OGLE & SUMMERS' STEAM CARRIAGE.

Reprinted from the RAILROAD JOURNAL *of November* 10, 1832.

The first illustration is from the RAILROAD JOURNAL for November 10, 1832 (Volume I, No. 46), and shows a steam carriage invented and built in England by Messrs. Ogle & Summers. From the account given, it appears that this carriage actually made the trip from Southampton to Oxford and from Oxford to Birmingham, on the latter trip carrying 22 passengers. The figures or numbers of reference on the plate are explained as follows: "1, Helm by which the carriage is guided. 2, Seat for the conductor. 3, Coupé, like French diligences, for four persons. 4, Seat for outside passengers. 5, Hand-pump for filling tanks. 6, Seat for engineer. 7, Pipe for surplus steam. 8, Jigger by which the furnace is fed. 9, Flue or chimney. 10, Boiler. 11, Furnace. 12, Blower, worked by a strap around the axle. 13, Water tank. 14, Brake, regulated by a lever on the conductor's seat. 15, Carriage for eight inside. 15, Wheels, very strong; the spokes not here marked. 16, Springs on which the machinery rides. 17, Springs on which the carriage rests. 18, Frame connecting whole. 19, Machinery under the carriage. 20, Ash-box under the furnace. 21, Pump by which the engine forces water into the tanks. 22, Piston for working the pump."

No particular description of the machinery is given, except that there were two cylinders, 12½ in. in diameter, and the success of the carriage was attributed largely to the boiler, which was very strong but light, and had a large heating surface for its size. The pressure was carried up to 200 lbs. The speed on the journey varied from 10 to 14 miles on a level; seven miles was reached on a hill.

The second engraving is from the RAILROAD JOURNAL of November 17, 1832, and shows a steam carriage built by Walter Hancock to run between London and Greenwich. At that date it was stated that the inventor had been running it experimentally about a year, and had been for a month working it regularly on the road for hire. The boiler was a special feature of this carriage; it was a sectional or tubulous boiler, composed of tubes connected at top and bottom and held together by bolts; these tubes were surrounded by a cylindrical iron casing, in the bottom of which was the fire-box. This boiler, the inventor stated, had been tested up to a pressure of 400 lbs., but in ordinary working he used from 70 to 100 lbs. Of the machinery no description is given; but apparently the cylinders were connected to the rear axle, the steering being done from the front axle by a chain and pulleys. The engine and boiler were carried on the back end in a large compartment, the front part consisting of two coupés for passengers.

These carriages disappeared when actual trial had proved that steam power could be applied to very much better advantage on a railroad, and the Liverpool & Manchester Railroad trials may be said practically to have put an end for the time to further experiments on steam carriages for common roads.

At present we have nothing to show what was the subsequent history of these two steam carriages. It would be interesting to know how long they continued in use and what finally became of them.

Making some allowance for the imperfections of the old engraving, and for some change in fashion of carriages, the Ogle & Summers carriage does bear a family resemblance to M. Serpollet's new device. Probably the idea will come up again from time to time, and some day it may come into use; but progress is to be made now by small improvements in the engine and generator. The general idea was certainly not new even in 1832, for it antedates the first railroad by many years.

That it has been revived in this country as well as abroad, the Patent Office records will show. Some engineers will perhaps remember also a steam carriage which was built about 1858–61, by an artist named Fisher, in New York, but never quite reached the point of successful work.

NOTES ON COMBUSTION.

BY C. CHOMIENNE, ENGINEER.

I.—PRELIMINARY DEFINITIONS.

CHEMICAL combinations are generally accompanied by a greater or less disengagement of heat.

When they proceed slowly, as when iron is oxidized in the air, the heat disengaged is not sensible, but if they proceed quickly the disengagement of heat is very intense and we have then combustion.

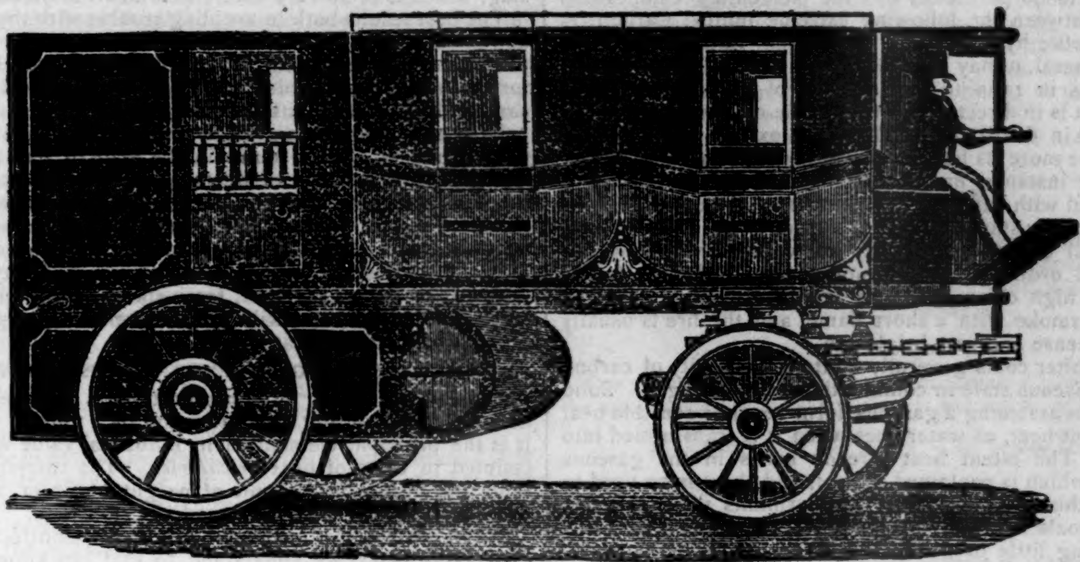
What we call combustion includes all chemical combinations in which there is a simultaneous disengagement of heat and light. In the combustion which we find in ordinary fire-boxes carbon and hydrogen combine with the oxygen of the air.

There are two kinds of combustion, the complete or total and incomplete or partial.

In complete or total combustion the carbon is transformed into carbonic acid and the hydrogen into water, and there is complete oxidation.

In partial combustion we simply transform the carbon into carbonic oxide. We decompose water and the ternary compounds of certain combustibles into a mixture of hydrogen, more or less carburetted, and of carbonic oxide.

In this way we obtain gases which are very combustible and which in their turn serve for the production of heat. The apparatus in which this transformation is effected are called gas generators, and the operation itself gasification of solid or liquid combustibles. We use this process whenever a gaseous fuel is more useful or more convenient than the ordinary fuel.



HANCOCK'S STEAM CARRIAGE.

Reprinted from the RAILROAD JOURNAL *of November* 17, 1832.

There are nevertheless combustions in which oxygen has no part. For instance, if we place antimony in a finely divided state in a flask filled with chlorine, it will unite with the chlorine with an active production of heat and light and will form chloride of antimony.

A combustible in the ordinary acceptation of the term is a combination of carbon which may be solid, liquid, or gaseous, and which when combined with oxygen, produces the phenomenon of heat.

Generally speaking, the development of heat is accompanied by flame, because the substance produced by the combustion is gaseous ; such is the case with coal.

Combustion, however, is not necessarily accompanied by flame or even by a setting free of heat. For instance, magnesium burns with a considerable disengagement of heat or light but without flame, because the product of combustion is not a gaseous body but a solid one, oxide of magnesium. In the same way iron in a very finely divided state plunged in oxygen produces also the phenomena of heat and of light, but without flame, because the result of combustion is oxide of iron.

If the same iron in a lump is exposed to a moist atmosphere it will not burn, but it will be gradually converted into oxide as in the first case. Here we have combustion without the phenomena of heat and light, but nevertheless if we consider the case carefully we will see that heat is produced and that this quantity of heat is precisely equal to that obtained more rapidly when the iron is exposed to oxygen in the condition of fine powder ; but in the second case the heat is developed very slowly and is dispersed as soon as produced, while in the first the rapidity of production is greater than that of dispersion, and the heat developed serves to make the mass red-hot and to produce the phenomenon of light.

Combustibles or fuels are divided into three classes :

1. Solid fuels, which are the most numerous and the most generally employed.
2. Liquid fuels.
3. Gaseous fuels.

We distinguish also natural and artificial fuels. Natural fuels are those which are found already in nature, such as vegetable fuels, like wood or turf, and mineral fuels, like lignite, coal, and anthracite or hard coal. These mineral fuels have a vegetable origin, and their composition is generally nearer to that of wood or turf, as the strata in which they are embedded are of more or less recent origin.

The combustion which is most used is that which results from carbon in the state of coal. In most cases it is found in considerable quantities, and the price is generally lower than that of any other fuel.

The combustion of coal is, then, that which we must consider in order to see how it proceeds when it is used to make steam through the medium of an ordinary grate, and to ascertain what is the best and most economical method of using it.

II.—THE COMPOSITION OF COAL.

As coals of all sorts may be used to burn in fire-boxes of steam boilers, it is of considerable importance to know their composition and the manner in which they behave in the fire. The best classification seems to be that adopted by Grüner in his study on the Coal Basins of the Loire. He divides them into five types, according to the nature and proportion of the fixed carbon, following rather the analysis by distillation than the ordinary elementary analysis. These five classes are as follows :

1. Dry coals with long flame. These have from 75 to 80 parts of carbon, and will furnish from 50 to 59 per cent. of carbon in rapid combustion.

2. Oily coals with long flame, or gas coals. These have from 80 to 85 parts of carbon, and will furnish from 59 to 67 per cent. of their weight in carbon for rapid consumption.

3. Ordinary soft coals or forge coals. These have from 84 to 89 parts of carbon in composition, and will furnish from 67 to 74 per cent. in the fire.

4. Soft coals with short flame or coking coals. These have from 88 to 91 parts of carbon in composition, and will furnish from 74 to 82 per cent. in the fire-box.

5. Hard coal or anthracite, having from 90 to 93 parts of carbon and furnishing from 82 to 90 per cent. of carbon in the fire.

It will be seen that the proportion of fixed carbon varies from 50 to 90 per cent., and the elementary composition varies between the following extreme limits: Carbon, 75 to 93 parts; hydrogen, 6 to 4; oxygen, 19 to 3.

In general, it may be said that the heating power of coal increases in ratio to the amount of carbon. In other words, it is in direct proportion to the carbon which is disengaged in distillation. The more oxygen the coal contains, the more its heating power diminishes. Anthracite coal, for instance, has a very high heating power, but it is lighted with difficulty, and sometimes requires special apparatus for starting the fire and for draft. These coals burn well only when broken up within certain limits of size, and ordinary draft is not usually sufficient, forced draft or high chimney stacks being necessary. It burns without smoke with a short flame, and the fire is usually of an intense and very bright red.

The softer coals generally contain a quantity of carbon in the gaseous state in combination with hydrogen. Solid carbon in assuming a gaseous form requires sensible heat and latent heat, as water does when it is transformed into steam. The latent heat already exists in the gaseous carbon which is contained in coal, and there is no need to furnish this in the fire-box. This explains the superiority of soft coals with a short flame, and in general the coals containing little oxygen. They have the property of developing intense heat in the fire-box, and are much desired for use as steam coals. Their value depends on the state of cohesion and also to some extent on the coking power —that is, the extent to which the coal will fuse and run together under the action of a high degree of heat.

In general coal has less coking power, as it includes a larger proportion of oxygen, and greater coking power as the proportion of hydrogen is relatively increased. Its value also is less, other things being equal, as the proportion of cinder is greater. The richer a coal is in carbon the greater usually is its density. Something, therefore, will be indicated by the weight as to its value as a combustible.

We have already stated that carburets increase the heating power of the coal very considerable by reason of the free carbon which they contain. We are not surprised then to find that we obtain a high heating power with coal containing earthy matters, provided they are rich in what we may call coal-tar. However, there are certain results which we have tried in vain to explain. For instance, we may take two coals having the same elementary composition, but which give entirely different results in combustion; the most simple and only reliable way is to try them in the fire-box before judging of their value.

The cinder resulting from the combustion of coal has during its period of formation inconveniences more or less serious, depending on the nature of the coal and the composition of the cinder itself. If the coal is soft or oily, that is to say, of a kind which develops a sufficiently intense heat, the cinders will melt and run together upon the grate, preventing air from passing through freely; the fire will be poor and it will become necessary to break up the cinder or slag.

Hard coals with little flame do not generally fuse the earthy matters mixed with them, and, on the other hand, they generally contain a very small proportion of gaseous carburets. The heat in the fire-box is less intense and is not sufficient to melt or fuse the cinders, and they will generally fall through the grate without clogging or closing it. Something, however, depends upon the composition of the cinders themselves. Generally they contain silica, alumina, lime, oxide of iron, etc., in variable proportions. Silica and alumina will not form a fusible compound. If the silica is mixed with lime, the cinders are apt to become caked, and when they contain iron they will melt and become more fusible as the proportion of the iron is greater; thus coal containing pyrites is especially troublesome and apt to block up the grates.

Cinders may be divided into fusible and infusible.

White or light colored cinder is generally infusible and separates from the fire in the state of fine powder. Colored cinders, especially those which contain iron and lime, are apt to melt or to run off without interfering with combustion. The most unfavorable case is that of cinders which may be called demi-fusible. It is this which cakes and fills up the cavities in the grate, assuming the form of slag, which is often very hard and difficult to break up.

The best results both in avoiding trouble with the cinder and in securing a good fire, is arrived at by using a composition of different coals. It often happens that the mixture of softer and harder coal gives better results than can be obtained with either one separately.

Most coal contains a greater or less proportion of sulphur, which is usually found in the state of iron pyrites. Too high a proportion of this injures a coal for combustion, because in the fire-box the sulphurous acid which is produced combines with steam and is transformed into sulphuric acid, which rapidly corrodes the iron or steel plates of the fire-box. This action is increased very much where there is a light leak, for instance, along the lines for rivets. Corrosion will then become very rapid and the boiler will degenerate quickly.*

III.—HEAT RESULTING FROM THE COMBUSTION OF COAL.

The calorific power of a combustible is the amount of heat developed during its combustion by a unit of weight. It is the principal element in its industrial value which is counted in units of heat or *calorics*. The *caloric* represents the heat which a unit of weight of water absorbs when its temperature is increased 1° Centigrade.

When we say that a certain fuel has a calorific power of 8,000 *calorics*, we understand by that one kilogram of that fuel can raise the temperature of 8,000 kg. of water 1°; it being understood that the combustion is complete, and that the heat developed has been applied entirely to heating the water.

A large number of careful experiments recently made at Mülhouse have showed that the heat of combustion of coal is very variable and cannot be predicted beforehand, sometimes being greater than the calculated amount, sometimes falling below. It can only be said that the heat developed by combustion is almost always greater than that calculated by the old formulas, and often greater than that theoretically due to the combustion of the total carbon and hydrogen contained. The only method, therefore, to correctly ascertain the heat developed is to burn it in a calorimeter.

M. Cornut, who has made many experiments, has proposed that we consider the carbon as divided into two parts: one fixed, which forms coke, and the other volatile, which is disengaged when coal is distilled. Many other formulas and methods have been proposed, but without proceeding into a complete analysis of all of them, we may say that so far it has not been possible to draw any theoretical conclusion from a comparison of results obtained in the calorimeter with those furnished by the formulas; and that the conclusions based upon the chemical composition of coal seem to be unreliable. All that we can say is that the more hydrogen a coal contains and the more water is formed in burning, the greater the difference between the figures.†

IV.—THE GRATE.

The surface of the grate must be in proportion with the quantity of coal to be burned. When it is too small it

* A number of tables which are given in the original paper show the composition of different coals, and are not repeated here, since they relate entirely to the product of different local mines and have no application here.

† The theoretical portions of this section of the article has been considerably condensed, for the reason that most of the formulas given relate especially to coals of local production and might not be applicable in this country.

will be necessary to clean up the fire frequently; if it is too large, the layer of fuel becomes too thin, and part of the air will pass directly through the fire and will have the effect of cooling off the boiler. Moreover, the fire will be uneven and the combustion will vary at different points.

The grate surface varies also with the kind of boiler and more especially with the kind of coal.

For natural draft there is usually a consumption varying between 0.50 and 1 kg. About 0.75 kg. per hour and per square decimeter of grate surface is the average figure which applies very well to ordinary soft coals. For coke, turf, or wood the figures will vary. The consumption of coke will vary between 1 and 2 kg. per square decimeter of grate surface per hour, according to the intensity of the draft. In marine boilers, where forced draft is used, the consumption varies from 2 to 2½ kg., and in locomotives, where the draft varies from 25 to 75 mm. pressure, the consumption will vary between 2 and 3½ kgs.

The grate-bars should be narrow and placed close together in order to permit the passage of as much air as possible and to distribute it regularly through the fuel. The finer the coal employed the closer the bars should be. The dimensions most generally adopted for ordinary coal, well broken up, is to make the bars from 12 to 15 mm. wide with spaces of from 5 to 7 mm. between. Their depth at the center should be from 100 to 150 mm. and at the end 60 mm. In this way we obtain as complete a division as possible of the air used in combustion, the grate-bars are less exposed to being burned and will last longer. For wood and for lump coal which does not break up much, the interval between the bars can be increased to 10 or 12 mm., and the thickness of the bars themselves to 25 mm. In some places grates are used of flat bars of iron, 1×8 mm. in section, riveted to cross-bars in such a way as to leave an opening equal to the width of the bar. With this system coal of any size can be burned without losses by sifting through.

A length of 1.80 m. should not be passed; beyond that the maintenance of the fire become difficult and hard for the fireman.* Some engineers do not wish to go beyond 1.60 m. and prefer to make the grate wider in order to obtain the necessary surface. In exceptional cases the grate is made as much as 2.20 m. in length, but in such cases it is necessary to put in additional bearers, so that the grate-bars will not be too long.

In boilers furnished with re-heaters or combustion chambers these large grates have the advantage of being favorable for a strong draft, for then there is sufficient surface to absorb the heat generated.

The width of the grate must be determined by the size of the boilers.

The grate should be from 0.30 to 0.55 m. from the nearest point of the heating surface, according to the size of the boiler, in order to prevent the cooling or breaking up of the flame by too direct contact with the heating surface. When the distance of the fire-box from the boiler is too great, the gases rising vertically are not well mixed and the radiating effect is diminished.

At the end of the grate-bars some play should be left to admit of their expansion. This is 0.0012 at the temperature of 100°, or at 500° it would be 0.006.

Grates are generally placed horizontally, but where exterior fire-boxes are used an inclination varying from 1 in 8 to 1 in 10 toward the back end is frequently given, and the same practice is sometimes followed in locomotives. This arrangement has the advantage of leaving more space for the development of the flame without decreasing the opening for ashes and of giving more space for the entrance of air.

The height of the grate in a stationary boiler should be such as to admit of the easiest work in making up the fire and in cleaning out, in order to make the work of the firemen as light as possible.

A grate of 2 sq. m. surface should be considered as a maximum which we ought not to pass in practice. If a larger surface is needed, it is better to employ several fire-boxes and several grates.

* This length (about 6 ft.) is often passed in this country, especially in locomotive boilers where anthracite coal is burned and where in some cases the fire-box is from 10 to 14 ft. in length. It does not follow, however, that such long fire-boxes are advisable.

Soft coal burning with a long flame and rich in hydrogen needs a longer grate and one placed at greater distance from the heating surface. Inclined grates, where the fire is fed automatically either by hoppers or by a screw device which deposits the coal upon the grate, have the great defect that the distance of the fire from the heating surface is increased, this diminishing the important action of direct radiation. Such devices can only be economical in a few special cases, and their general use is not advised.

V.—TO CALCULATE THE DIMENSIONS OF A GRATE.

If we assume $s =$ the grate surface desired; $p =$ the weight of fuel burned per square meter per hour; and $N =$ the calorific power of the fuel, the weight of the fuel burned per hour will be $p\ s$, and, if the combustion is complete, the heat disengaged will be $p\ s\ N$.

But the heat actually utilized is much less, owing to incomplete combustion, cooling of the fire-box and the disengagement of gases of combustion at a high temperature; it follows, therefore, that we can utilize only a fraction of the theoretical total heat. This fraction we can call the resultant, and indicate it by r; in practice it varies from 0.50 to 0.80.

If, then, we have to produce a quantity of heat represented by X, we will have:

$$X = r\ p\ s\ N.$$

Suppose that we have to produce 1,000 kg. of steam per hour. The number of *calorics*, or units of heat, necessary to vaporize to a temperature of t° one kilogram of water taken at t'° is given by the formula

$$n = 606.5 + 0.305\ t - t'.$$

For steam at a pressure of 5 atmospheres, $t = 152^{\circ}$.* If the temperature of the feed water is 12°, we have,

$$n = 606.5 + 0.305 \times 152 - 12 = 640.86,$$

and therefore,

$$X = 1000 \times 640.86 = 640{,}860 \textit{ calorics}.$$

If we assume a resultant $r = 0.60$, and if we use a coal having a heating power $N = 7000$ *calorics*, we will have:

$$640{,}860 = 0.60 \times p\ s \times 7000$$

$$p\ s = 152.5.$$

If we assume $p = 75$ kg., then

$$s = \frac{152.5}{75} = 2{,}03 \text{ sq. meters.}$$

This gives us the grate surface desired. If we make the length of the grate 1.80 m., the width will, of course, be $2.03 \div 1.80 = 1.12$ m.

VI.—THE ASH-PAN.

The ash-pan or ash-box is the space below the grate into which the ashes and cinders should fall. It is important that it should have such a depth that the hot ashes and burning cinders which fall into it will not radiate too much heat on the lower side of the grate. If the depth is not sufficient the grate-bars will be between two fires, and be quickly destroyed, so that frequent renewal will be required. A very common practice is to place in the bottom of the ash-box a cast-iron pan which is filled with water. The object of this is to extinguish and cool the cinders which fall from the grate and to prevent any injurious effect on the bars. Moreover, the surface of this pan of water has the advantage of showing the fireman the state of combustion on the grate by reflection. If the reflected light is irregular and there are black patches, it shows that the combustion is imperfect in corresponding parts of the grate, and the fireman should look carefully at his fire in order to level off the bed of coal.

The ash-box must be provided with doors conveniently arranged, which can be shut when necessary. These

* The temperatures here given are on the Centigrade scale. Reducing them, 152° Cent.=305.6° Fahrenheit, and 12° Cent.=53.6° Fahr.

doors serve, with the damper, to prevent too great a circulation of air in the boiler when the fire is damped down for the night, for instance, or when it is not in active use, and will keep the fire in condition to come up quickly when it is again needed, thus effecting economy of both time and coal.

(TO BE CONTINUED.)

THE MEXICAN CENTRAL COMPOUND LOCOMOTIVE.

THE accompanying cut shows the general appearance of the compound locomotive with which the trials on the Mexican Central Railroad were made, as described by Mr. F. W. Johnstone, the Superintendent of Motive Power, in the June number of the JOURNAL. As then stated, the engine was of the consolidation type, with 20 × 24 in. cylinders and 50 in. drivers. It was changed to a compound by putting in new cylinders, arranged on the plan devised by Mr. Johnstone, the high-pressure cylinder, 14 × 24 in., being inside and the low-pressure cylinder forming a ring outside it. As the best way of showing this arrangement, we reprint herewith the diagram, fig. 1, showing a section through the cylinders and steam chest. The total diameter of the

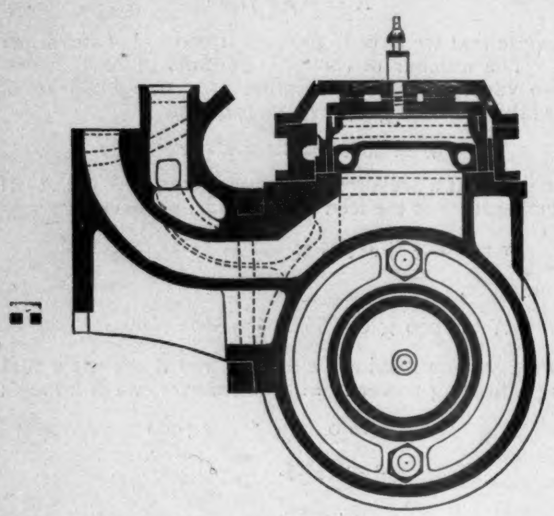


Fig. 1.

low-pressure cylinder is 30¾ in., its area, after deducting the space taken by the high-pressure, being equivalent to that of an ordinary cylinder 24¼ × 24 in. The ratio between the two cylinders is 1 : 3.

The methods adopted in making the tests and the results obtained were fully described last month. These results were so good that the company has decided to change a number of its engines in the same way, and is having several new ones of the same pattern built.

THE AVERAGE OBSERVER.

THE following article, which is sent by a contributor to the *English Mechanic*, though not strictly scientific, is very interesting, and will no doubt confirm the experience of many of our readers :

My general attitude of caution in all matters of average testimony secures for me so much misunderstanding, that it is quite refreshing to find my views shared by sounder judgments than my own.

The following record of a series of experiments made to test the reliability of "the average observer" may interest some of your readers, especially as I believe no such data are on record. I suppress the names of the participants, but they are at the disposal of any scientific reader who desires corroboration of my notes.

The circumstances which gave rise to the experiment were these : In January, 1882, a civil action was tried in the Queen's Bench. In it an important question turned on what really took place at a certain interview at which five persons were present. It was alleged by the plaintiff that on the occasion in question he entered a room carrying in his hand a sheet of foolscap rolled longitudinally ; that he laid it upon the table in the sight of all present, and that once during conversation he distinctly indicated it by a gesture. This story was corroborated in the main by two gentlemen, disinterested parties in the action, but was totally denied by two others, equally disinterested. The jury delivered the defendant's version.

These facts, and the discussion they excited among certain friends, induced me to carry out the following experiments one evening after dinner. I asserted the broad proposition that I should enter the room, remain an indefinite number of minutes, perform distinct actions, and make distinct remarks, and that in no case would all of the seven observers present agree in describing accurately, five minutes afterward, either in writing or orally, all that I did.

To insure accuracy, I drew up privately a detailed programme, describing exactly what I did do, and held it in my hand for reference. The conditions were that I should enter the room twice, performing a distinct set of actions each time, and that after an interval of five minutes from the conclusion of my second entrance, each person should describe in writing whichever of the two entries I indicated. There was to be no prompting, and no amending what was once written. A description of my first entry will give an idea of the character of the experiments.

Entered room, carrying book in right hand ; advanced toward table ; slightly moved chair ; sat down in it long enough to open book ; read aloud title-page ; remarked, "This is from Jones's collection ; I have the original edition, but the bindings are shabby ;" rose, carrying book ; walked to piano ; adjusted music on stand ; asked B. if he had heard Pinsuti's latest song ; laid book on piano-lid ; stood on hearthrug with back to fire ; made remark to C. ; looked at watch, and, retaining it in hand, left room, laying book on sideboard as I passed, and, in closing door, appeared to have difficulty in turning handle. Time occupied, 4½ minutes.

The second entry was a little more elaborate, the number of distinct actions being 13 ; time occupied, 6 minutes.

I selected entry No. 1 for description. Result : No one described all I did ; three omitted incident at piano ; two omitted remark made on hearthrug ; three blundered over order of procedure. None repeated accurately any one remark. In cross-examination, the results were yet more surprising. Here are a few questions I asked, with the number of correct replies : "In which hand was book ?"—three. "With which hand did I remove chair ?"—four. "On what portion of the piano-lid did I place book ?"—five. "With which hand did I open door ?"—four.

Eight other tests were made, and 36 questions were asked in cross-examination. To only three questions were the answers unanimous.

It may, of course, be objected that these were practically tests of memory, and to a large extent this is the case. But what is to be said for the following cases of distinct misperception ?

The answers to these questions were not given verbally, but written down. 1. "Where were my glasses ?" (*pince-nez* attached in usual way by cord). A. answered correctly. B. said, "In right hand ;" D., on nose ; E., did not notice ; F., uncertain—thought they were on ; G., certain they were held in left hand. They were in my watch-pocket.

Question 2. "How long was I in the room ?" A., about ten minutes ; B., not ten ; C., uncertain ; D., over ten ; E., about fifteen ; F., from five to ten ; G., uncertain—should say ten minutes ; actual time, 4½ minutes.

I may here remark that in only one case did any one estimate the duration of time within three minutes of exact period in any subsequent test.

Question 3. (Asked at conclusion of 8th entry.) "How many times had I passed within touching distance of a small table situate in corner opposite door ?" A., about five ; B., ditto ; C., three ; D., "almost every time ;"

E., could not say; F., dubious—perhaps three; G., four. I had carefully refrained from approaching within five feet of it. In order to insure certainty I placed a mark on the door. For my fourth and seventh entries I changed my dress coat for a black cutaway coat. Two ladies noticed it, but only one gentleman "fancied there was some change." Before 2d, 4th, and 7th entry I removed my watch chain—a large and prominent one. In answer to questions put at the end of the last entry, four admitted having noticed its absence, but no one could specify at which entry it was absent.

It must be admitted by all that the conditions under which these tests were made were unusually favorable for careful and accurate observation, for not only were all on the lookout, but they practically knew what to look for. If under such favorable circumstances the results were so diversified, as the appended analysis shows, what is likely to be the average of reliable results under conditions which are not abnormal? In order to assist in estimating the value of the test, I give the profession or calling of each observer.

The number of distinct actions performed was 176, and in the following table of results I divide them thus: *a*, actions unobserved; *b*, actions misdescribed—*i.e.*, so inaccurate as to convey an erroneous impression of the act; *c*, actions misplaced in order of sequence; *d*, actions which were not remembered or not noted with sufficient clearness to be recorded:

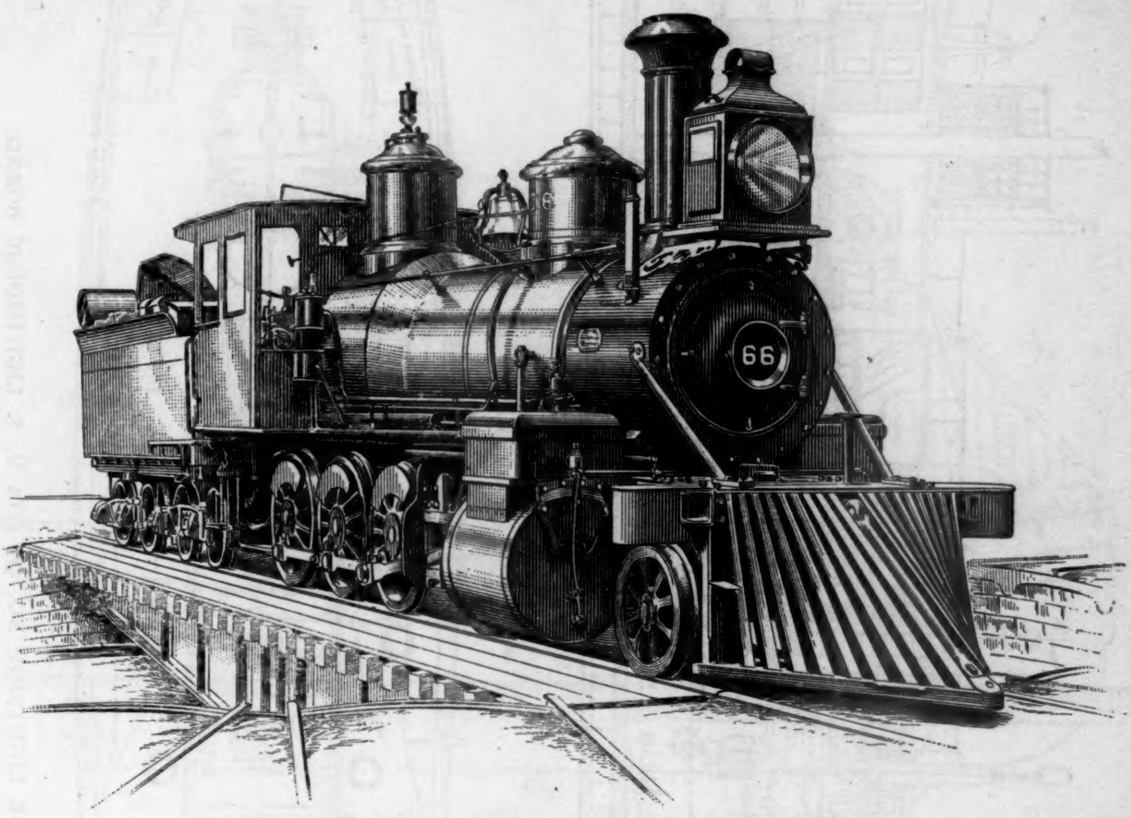
Land Surveyor	*a*. 3,	*b*. 4,	*c*. 1,	*d*. 5	—Total 13
Stockbroker	*a*. 5,	*b*. 5,	*c*. 3,	*d*. 5	—Total 18
Newspaper Editor	*a*. 2,	*b*. 5,	*c*. 11,	*d*. 7	—Total 25
Organist	*a*. 6,	*b*. 7,	*c*. 4,	*d*. 10	—Total 27
Commercial Man	*a*. 5,	*b*. 9,	*c*. 3,	*d*. 11	—Total 28
Solicitor	*a*. 3,	*b*. 3,	*c*. 3,	*d*. 23	—Total 32
Bank Clerk	*a*. 8,	*b*. 7,	*c*. 1,	*d*. 17	—Total 33

An analysis of this list might be interesting if taken in relation to the professional training of the percipients. But for his excessive caution, the solicitor would probably have led the list. With the exception of the bank clerk all the observers were men over 30, and all appeared genuinely interested in the experiments.

A feature which struck me greatly was the proneness of the observers to connect an action in the later series with some analogous action witnessed earlier in the evening. No one was free from this blunder. The sole misperception in the continuity of actions of which the bank clerk and surveyor were guilty were in this direction. The latter connected an act in the 8th entry with one in the 3d; the former connected the 1st and 5th entries. The large number of misses under the head of uncertainties is explainable by the anxiety of the observers to approximate a judicial frame of mind, as our legal friend put it.

I may add that the figure in class *b* in the bank clerk's score is indistinct in my notes. It may be 9, but I give him the benefit of the doubt.

Two ladies were present, but I kept no record of their observations. The little they did confirmed the popular tradition that ladies have keen eyes for detail. Both noticed every change in my appearance.



COMPOUND LOCOMOTIVE, MEXICAN CENTRAL RAILWAY.

DESIGNED BY F. W. JOHNSTONE, SUPERINTENDENT MOTIVE POWER.

A LIGHTSHIP WITH ELECTRIC LIGHTS.

THE United States Lighthouse Board has recently invited bids for four new lightships of a greatly improved pattern. The accompanying illustrations show one of these ships, No. 51, which is to be stationed at Cornfield Point, Long Island Sound. Fig. 1 is a general view; fig. 2, a longitudinal section; fig. 3, a deck plan; figs. 4 and 5, cross-sections; fig. 6, a view of the light platform. The description herewith is condensed from the specifications.

The general dimensions are: Length over all, 118 ft. 10 in.; length from inside of rudder-post to inside of stem, 110 ft.; beam, molded, 26 ft. 6 in.; depth of hold, from top of beam to top of keel, 14 ft. 6 in. In addition to the sails carried on the light masts, the ship will be provided with a propeller and steam power, which will not only enable her to return to her post if carried away by a gale,

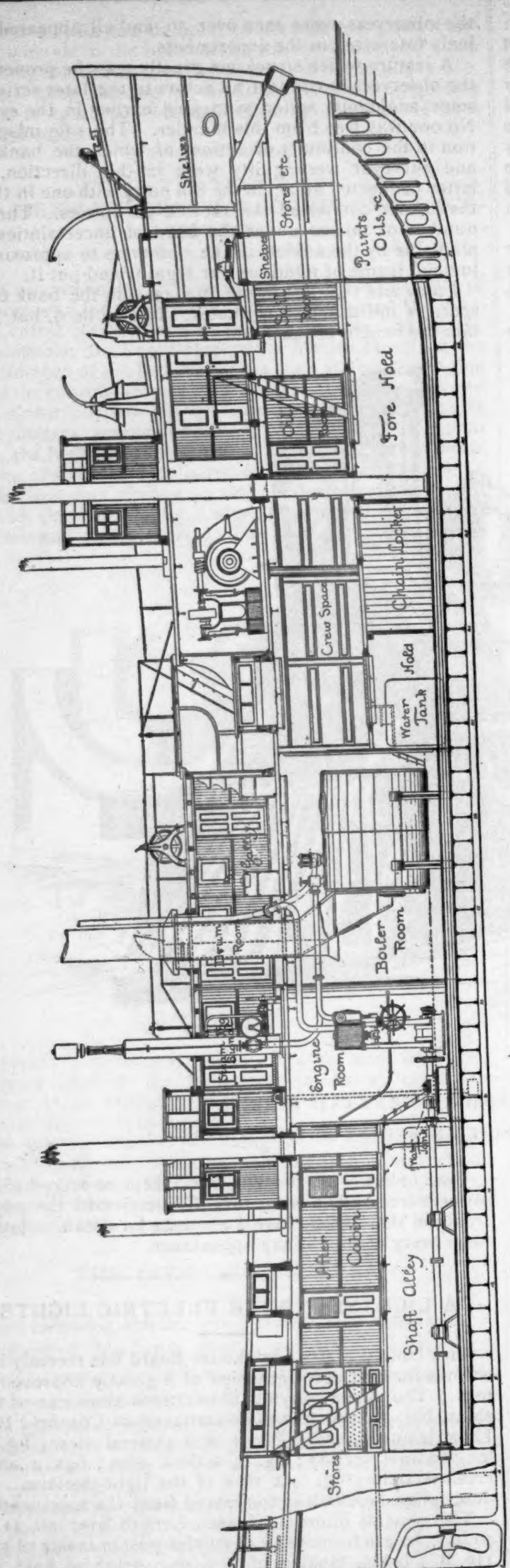


Fig. 2.

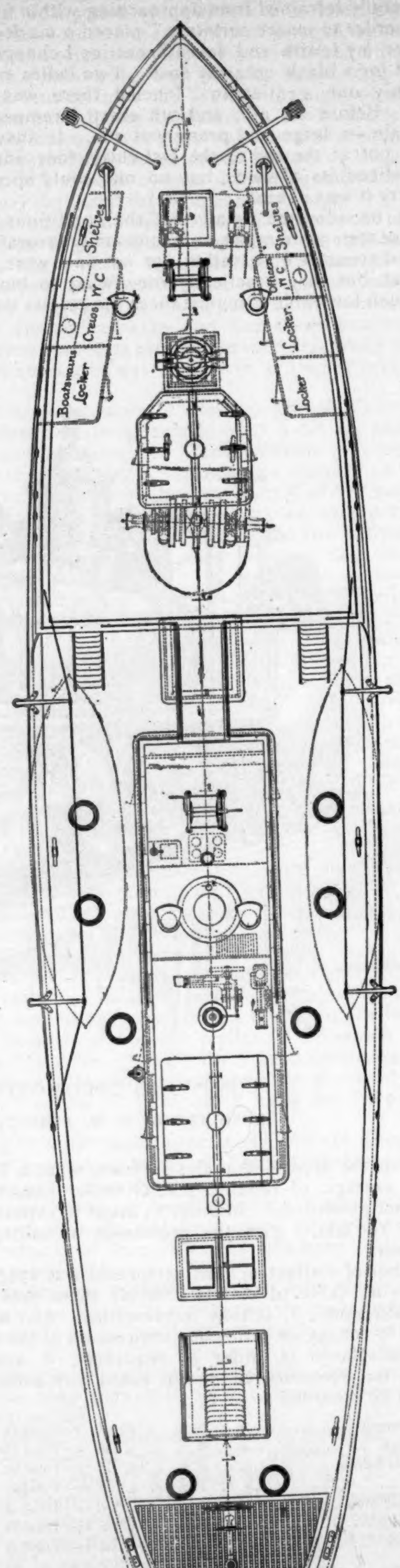


Fig. 3.

PLANS FOR LIGHTSHIP NO. 51, FOR U. S. LIGHTHOUSE BOARD.

but will also be of much assistance in keeping her in place, as they can be run during a storm, and thus diminish the great strain on the cables.

The hull will be built entirely of iron, strongly framed and braced. There will be four main bulkheads extending up to the main deck, built thoroughly water-tight. The vessels will have a bar-keel and a sternpost forged solid with the rudderpost, and arranged for propeller shaft in the usual way, and as shown on plans. All plates in the shell of the vessels, the bulkheads, bulwarks, etc., are to be machine planed, and no other method of fairing the strakes or preparing edges for calking will be allowed. The plating will be run in inside and outside strakes, perfectly fair, and smoothly fitted up and riveted. The vessels will be provided with one outside bilge-keel on each side of the vessel, extending for about 55 ft., constructed as shown on plans, and the run of these keels shall conform with the natural run of the water when the vessel is in motion.

Under the main deck, commencing aft, will be located storeroom, cabin, with four staterooms, coal bunkers, engine and boiler-room, crew space with 10 berths, lockers, wardrobes, tables, etc., pantry, oil-room, sail-room, and the forepeak will be fitted up as a storeroom with necessary lockers and shelves. Under lower deck, forward, will be located water-tanks, chain lockers, forehold, and a storeroom for paint, oil, etc. On the main deck aft will be placed steering gear, skylight, and companionway for cabin, and the main-deck house will extend from about frame No. 17 to about frame No. 35, consisting of lantern-room, pump, and fog-whistle machinery-room, and galley. Forward of this house, and under the forecastle deck, will be located a steam windlass with elastic chain stoppers, lockers, and water-closets for officers and crew, as shown on plans. On the forecastle deck will be located a lantern-house, hoisting engine, bell, etc., and on top of the main-deck house will be placed a steam fog-whistle and a hoisting engine; both the top of the deck house and the forecastle deck will be surrounded by a strong and neatly built iron railing. On the main deck will also be located two boats, necessary ringbolts, bitts, chocks, fairleads, scuppers, two hard wood stairs leading to the forecastle deck, and all other fittings for all purposes required by the service. The vessel will be rigged with two masts and trysail-masts arranged as shown on plans.

The cabin and crew-space will be heated throughout by steam, well ventilated and fitted with all necessary conveniences and arrangements for comfort. The fittings required for her special service will include one mushroom anchor of approved pattern, weighing 5,000 lbs.; one bower anchor, weighing 2,500 lbs.; one harbor anchor, weighing 2,000 lbs.; two 2-in stud-link bower chains, 120 fathoms each; one $1\frac{1}{2}$-in. stud-link mooring chain, 120 fathoms; one 2-in. stud-link spare chain, 15 fathoms; also a bell of 1,000 lbs. weight, mounted in an iron frame.

The masts are to be 67 ft. in length. The rigging will be of wire rope, and the sails arranged as shown in fig. 1. A lightning conductor will be carried on each mast.

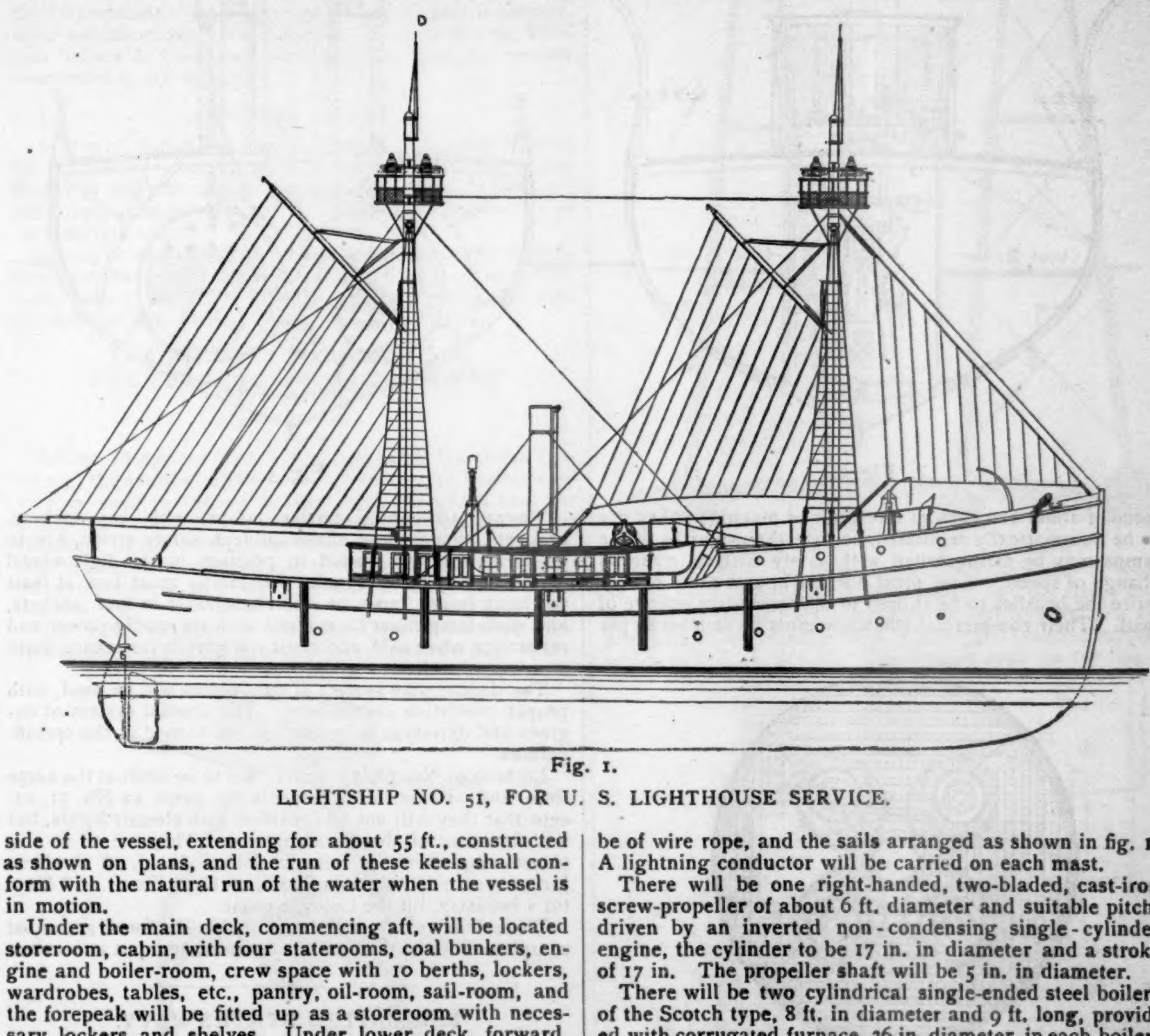


Fig. 1.

LIGHTSHIP NO. 51, FOR U. S. LIGHTHOUSE SERVICE.

There will be one right-handed, two-bladed, cast-iron screw-propeller of about 6 ft. diameter and suitable pitch, driven by an inverted non-condensing single-cylinder engine, the cylinder to be 17 in. in diameter and a stroke of 17 in. The propeller shaft will be 5 in. in diameter.

There will be two cylindrical single-ended steel boilers of the Scotch type, 8 ft. in diameter and 9 ft. long, provided with corrugated furnace, 36 in. diameter, in each boiler. There is to be furnished and fitted in place one horizontal, non-condensing engine, about 5 in. diameter of cylinder and 6 in. stroke, with properly attached machinery for operating the steam whistle; also one Baird's No. 3 distilling apparatus, with necessary evaporator, filter, pumps, etc., all to be arranged as shown on plans, and as will hereinafter be described and specified. The steam whistle will be 12 in. diameter of bell.

Lightship No. 51 will be the first one in the United States provided with electric light. For this purpose there will be two engines, which must be horizontal high-speed engines, with automatic cut-off governor; to be capable of developing 8 H. P. at normal speed, with 70 lbs. steam, cutting off at one-quarter stroke; governor to control speed accurately, and to be capable of adjustment to enable speed to be varied 20 per cent. above or below the normal.

Two pulleys, 32 to 36 in. diameter, with 5-in. flat face, will be required with each engine.

Engines will have no outboard bearing, and will have cast-iron base complete, ready to set on deck at floor level.

The dynamos are to be compound wound, and are to be of at least 60 amperes capacity, with an electro-motive force of about 110 volts at terminals of machine; they are to be automatically regulated, so that three-fourths of the lamps may be extinguished with safety without material change of speed. They must not spark, and must not require the brushes to be shifted to accommodate change of load. Their commercial efficiency must be at least 80 per cent. An Evans friction cone of the proper size to transmit the full power of the engine is to be furnished with each dynamo.

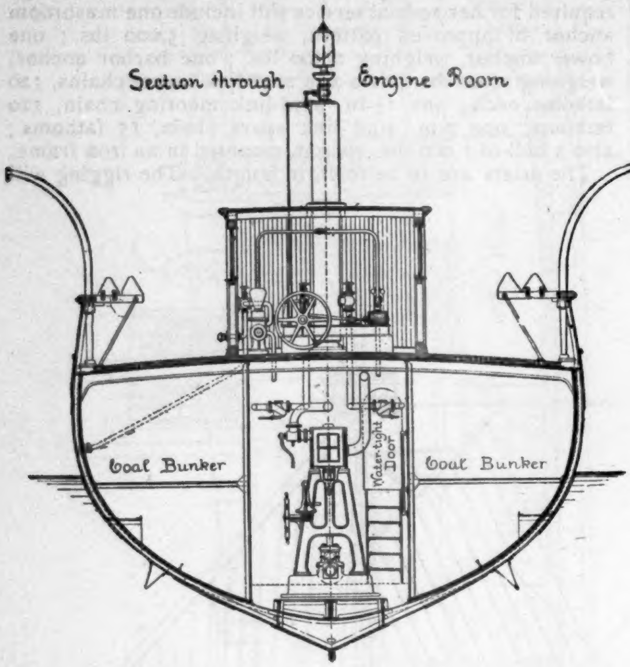


Fig. 4.

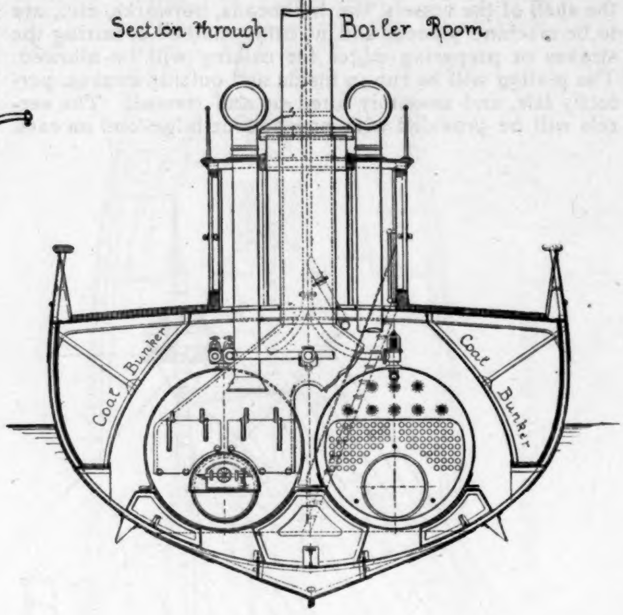


Fig. 5.

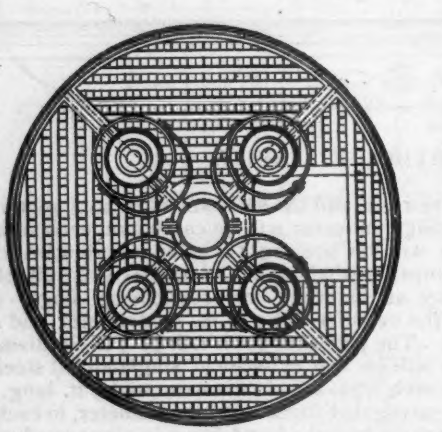


Fig. 6.

The engines and dynamos are to be so located that, with the Evans friction cones, either engine can run either or both dynamos. The dynamos will therefore be furnished with sliding bed-plates, so that they can quickly be thrown in or out of action.

The actual floor space occupied by the dynamos and engines must not exceed 8½ × 11 ft.

Attached to the engines or dynamos must be a device for alternately opening and closing, at regular intervals, the circuits to the lights at the mastheads; this device must be so made that the lengths of the intervals may be varied from 5 seconds to 20 seconds at will.

Eight 100 candle-power lamps with keyless sockets are to be furnished; the carbons of these lamps are to be coiled in a spiral according to the sample which will be supplied to the contractor.

Twenty 16 candle-power lamps, with key sockets, brackets, shades, and shade-holders, safety strips, are to be furnished and placed in position in the light-vessel where it may be directed. All lamps must last at least 600 lamp hours, must be interchangeable in their sockets, and each lamp must be marked with its candle-power and resistance when cold, and must not vary in resistance more than one ohm from a given standard.

The double wire system of conductors will be used, with proper insulation everywhere. The special system of engines and dynamos to be used is not named in the specifications.

Lightships No. 52, 53, and 54 are to be built at the same time, and will be in all respects the same as No. 51, except that they will not be provided with electric lights, but with lanterns of the usual pattern. They are to be stationed respectively at Fenwick Island Shoal, off the New Jersey coast; Frying Pan Shoal, off Cape Fear; and Martin's Industry, off the Georgia coast.

These four vessels will be probably the finest and most complete ships of their class ever built and put in service.

THE UNITED STATES NAVY.

THE new Naval Torpedo Board consists of Commander Converse, Lieutenants Drake and McLean. Their first work will be the testing of the Whitehead and the Howell automobile torpedoes ordered for the navy.

NAVY YARD EQUIPMENT.

In Washington, July 1, in the Bureau of Yards and Docks of the Navy Department, bids were opened for two 40-ton traveling cranes, to be erected, one each at the New York and Norfolk Navy Yards for handling heavy armor plates and placing them in position on the sides and turrets of ships. The bids were as follows:

Yale & Towne Manufacturing Company of Stamford, Conn., for both cranes, $92,200; for the New York crane, $47,100; for the Norfolk crane, $47,400.

Morgan Engineering Company of Alliance, O. for both, \$79,966.25 ; for either crane separately, \$45,093.75.

Southwark Foundry and Machine Company of Philadelphia, for both, \$71,522 ; for one, \$37,036.

Weimer Machine Works Company, Lebanon, Pa., for both, \$104,300 ; for the New York crane, \$52,500 ; for the Norfolk crane, \$53,000.

American Ship Windlass Company of Providence, R. I., for both, \$77,708 ; for the New York crane, \$38,579 ; for the Norfolk crane, \$39,189.

William Sellers & Company, Philadelphia, for both, \$55,465 ; for the New York crane, \$28,960 ; for the Norfolk crane, \$29,000.

The Yale & Towne Company, the Morgan Engineering Company, and William Sellers & Company each bid on their own modification of the specifications prepared by the Department. The other bids were all on the Department specifications. The contract was awarded to William Sellers & Company, who agree to have the cranes completed in six months.

REVOLVING CANNON.

A 37-mm. Hotchkiss revolving cannon has been ordered for the Marine School of Application in Washington. The limber of this gun carries 300 rounds of ammunition, and the supply is supplemented by 1,000 rounds carried in an ammunition wagon.

It may be mentioned also that batteries of 6-pdr. Hotchkiss guns have been ordered for the revenue cutters *Corwin*, *Colfax*, and *Bear*. Other revenue vessels will also be supplied with these guns as soon as possible.

THE GARRUCHA ROPE TRAMWAY.

(From *Industries*.)

AT the important iron ore mines in the Garrucha District in the south of Spain, a rope tramway, or aerial ropeway, is used to convey the ore from the mines near the village of Serena to the shore of the Mediterranean, for shipment at Garrucha. As this ropeway is, we believe, the most important aerial line that has yet been constructed, a description of it will no doubt be of interest to our readers.

The chief feature of this—the Otto—system of rope transport is the employment of *two fixed carrying ropes*,

FIG. 1

along which the buckets are hauled by a light endless running rope. The advantages of using fixed ropes are, that it is possible to carry heavy loads, cross large spans, and surmount the steepest gradients with safety. Without this system of transport these rich mines would probably not have been opened out, as the cost of an ordinary railroad would have been very great, and more than absorbed all prospective profit on the sale of the ore.

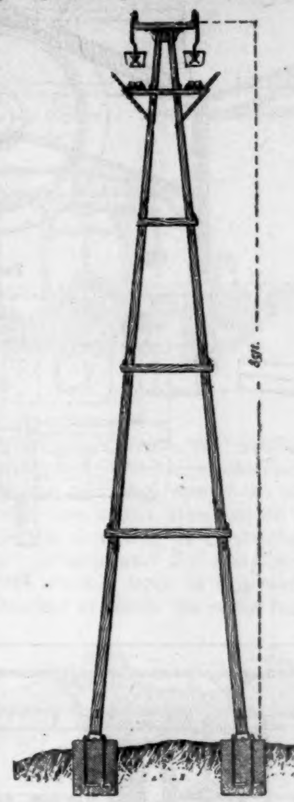


FIG. 2.

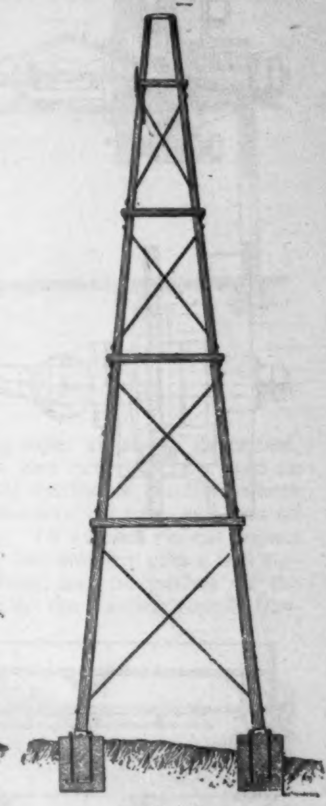


FIG. 3.

The standards for these lines are made either of wood or iron, and, according to their height and the strain they have to withstand, are either two or four legged. Figs. 2 and 3 show the design of a four-legged wooden support which is 85 ft. in height. The largest span on the line is

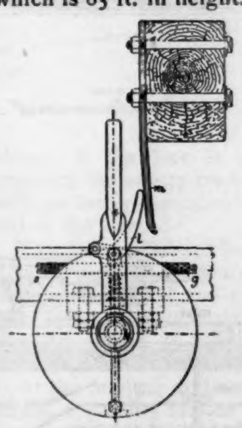


FIG. 4

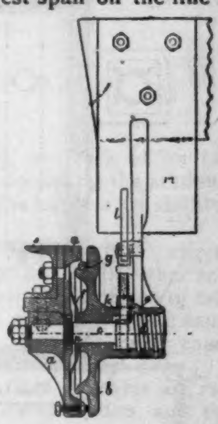


FIG. 5

918 ft., and is situated near the Villa Reforma. At this point no less than six empty and six full buckets are suspended at one time between the supports. One of the standards on this line has a total height of 118 ft. The two-legged supports are held in position with guy rods. Fig. 1 shows clearly the relative positions of the fixed and hauling ropes, and fig. 2 shows how the carriers pass the supports.

These carriers consist mainly of four parts—a truck or runner, a triangular-shaped hanger, the bucket or skip, and the grip for attaching the carrier to the hauling rope. The form of buckets depends largely on the nature of the material to be transported ; for ore, coal, etc., a bucket

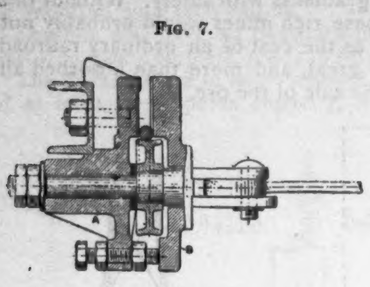


Fig. 7.

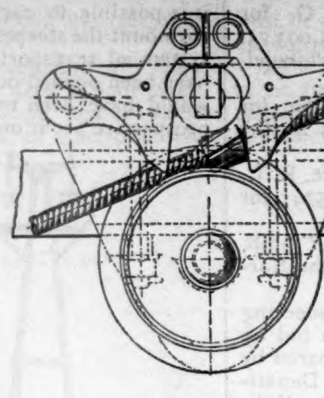


Fig 9

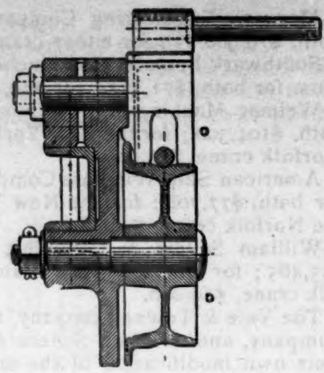


Fig 10

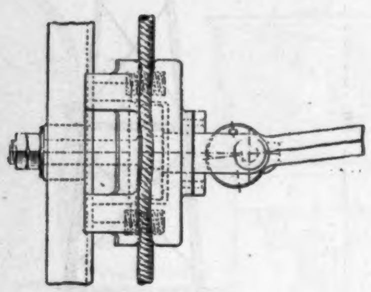


Fig. 8.

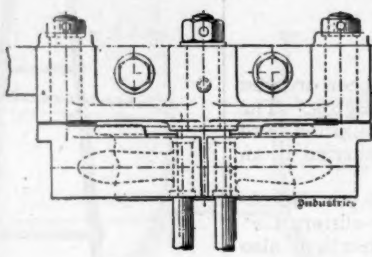


Fig 11

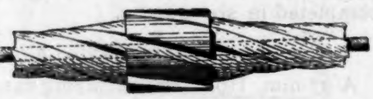


Fig. 12

Fig. 13.

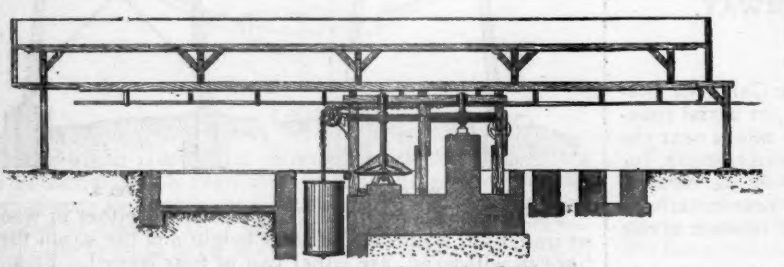


Fig 14.—Longitudinal Section of Angle Station.

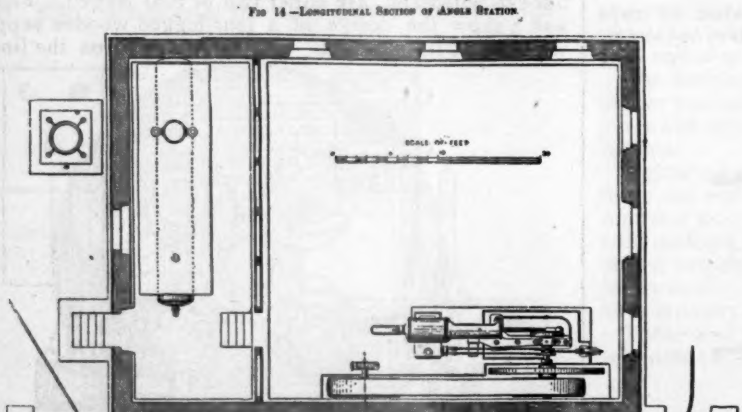


Fig. 15.—Sectional Plan of Angle Station.

arranged to be tipped by hand is usually employed, as illustrated in fig. 1. The buckets used on the Garrucha Line are of this form, and have a capacity of 784 lbs.

A most important detail, to insure regular and uninterrupted working of a line, is the form of grip that is adopted for attaching the buckets to the hauling rope. For lines with easy gradients friction grips are employed; these are of two kinds: the first, used for gradients up to 1 in 6, is shown in elevation and section in figs. 4 and 5, and consists of two smooth-faced disks, *a* and *b*, one rigidly attached to the cross-bar of the hanger, the other being free when out of action to revolve and act as a guide and supporting roller for the hauling rope. The spindle carrying the movable disk has a square thread on its outer end, and carries a lever, the boss of which forms the nut. If the lever is hanging down the disks do not grip the rope, and are kept apart by a spring. On raising the lever, however, through an angle of 180°, the disks are made to approach each other, and the hauling rope is tightly gripped between them. The lever is prevented from falling in transit by a small spring trigger. For gradients from 1 in 6 up to 1 in 3 a friction grip with corrugated jaws *A B* (figs. 7 and 8) has recently been employed, which differs from the disk friction grip above described, in that the movable plate or jaw *B* is corrugated and does not revolve, the pressure being obtained by means of a lever and eccentric, as clearly shown in the illustration. Both forms of grip work exceedingly well, and permit of the buckets being attached at any point of the hauling rope.

As on the Garrucha Line there are gradients of 1 in 2½, a friction grip would not be sufficiently reliable; it is necessary, therefore, to employ the pawl grip, shown in figs. 9, 10 and 11, representing a front

elevation, end sectional elevation, and general plan respectively. This consists of two symmetrically placed pawls *C C*, free to move in a vertical plane, with forked ends, which drop down on either side of the knots attached at intervals to the hauling rope. The hauling rope itself is carried on a roller *D* slightly below the pawls. To throw the pawls in and out of gear, pins are attached to their upper ends, and these at the stations come in contact with guide-rails which raise the pawls, automatically releasing the hauling rope and permitting the carrier to be switched off on to the shunt rails at the station. A large number of these grips, we are informed, are now at work, and in no instance have they been known to fail.

The latest and best form of knot, shown in figs. 12 and 13, has a star section, and has an outside diameter slightly in excess of that of the hauling rope. The strands of the hauling rope lie in the helical grooves as shown, the ribs forming the star projecting sufficiently above these to form a shoulder to press against the pawls of the carrier coupling. The knot is made fast to a steel wire strand *E* about 6 ft. long, which takes the place of the hempen core in the hauling rope; by this means it is rigidly held and any strain distributed, the strand forming the core being tightly gripped throughout its length by the strand of the hauling rope itself. The advantages of this form of knot are that it can be quickly attached to, and when worn removed from, the hauling rope without cutting the same; for fixing it is not necessary to employ white metal, which was found to very much impair the strength of the rope; moreover, the hauling rope does not lose its flexibility at

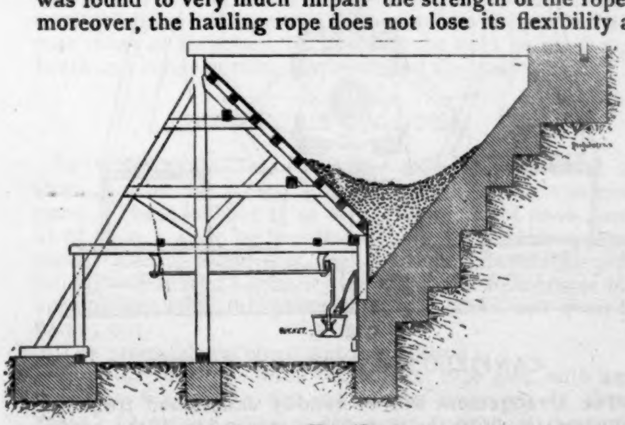


Fig. 18.

the point of attachment, and any breakage of single wires is at once visible and easily repaired.

As these lines cannot be worked round curves, it is necessary, provided the ropeway cannot be carried in a straight line from end to end, to insert angle stations. Figs. 14, 15 and 16 represent a longitudinal section, a sectional plan, and a transverse section of one of these angle stations at Puerto del Coronel, the chief power station of the line. When the buckets arriving from Bedar reach the shunt rail at the angle station they are automatically

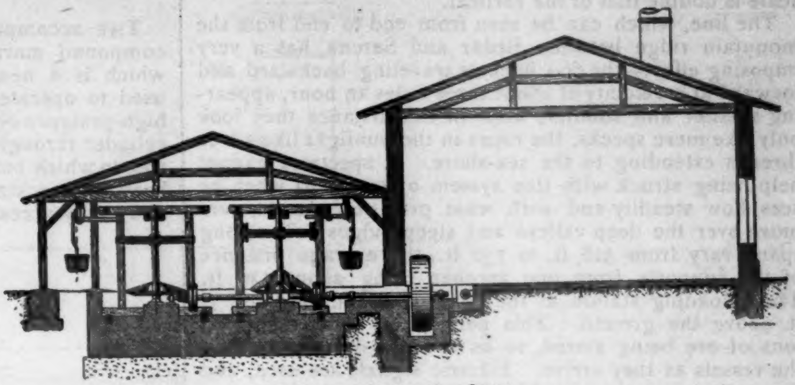


Fig. 16.—Transverse Section of Angle Station.

disengaged from the hauling rope, as above described, switched on to the shunt rails, and run round by hand on to the carrying rope of the next section of the line, where they are again attached to the hauling rope and sent off in the direction of Garrucha. To avoid a violent impact of the knot and the coupling, the shunter gets a bell signal when a knot is approaching, and he pushes off the bucket at about the same rate as the hauling rope is traveling. If the line is not required to work at its full capacity the empty buckets can be docked at the stations, sidings being provided on to which the buckets are shunted out of the way.

This line is divided into four sections, a 30 H. P. engine driving the two steeper sections, a 70 H. P. the other sections. In figs. 14 and 15 is also shown the method of taking up the slack of the hauling rope and keeping the same taut by means of balance weights. The carrying ropes are weighted at their ends in a similar manner.

At the loading station the trucks from the mine are run down a gravity incline to the ropeway station, and the contents tipped into bins or hoppers of a capacity of 800 tons. Fig. 18 gives a section of one of these bins, showing the buckets suspended from the shunt or hanging rail and the spouts for filling them. From the profile of the line, fig. 17, it will be seen that after leaving the loading station at Serena, which is situated some 905 ft. above the sea level, the line crosses a number of deep valleys, one upward of half a mile wide and 330 ft. deep, and traverses several mountain ridges, the highest being no less than 1,174 ft. above the sea level, to the village of Pinar de Bedar, where, at an elevation of 951 ft., the first engine house and angle station is situated. From here the line goes off at an angle to the right, and again passes over several valleys and ridges, with a gradual descent to a second angle station at an elevation of 370 ft. It then

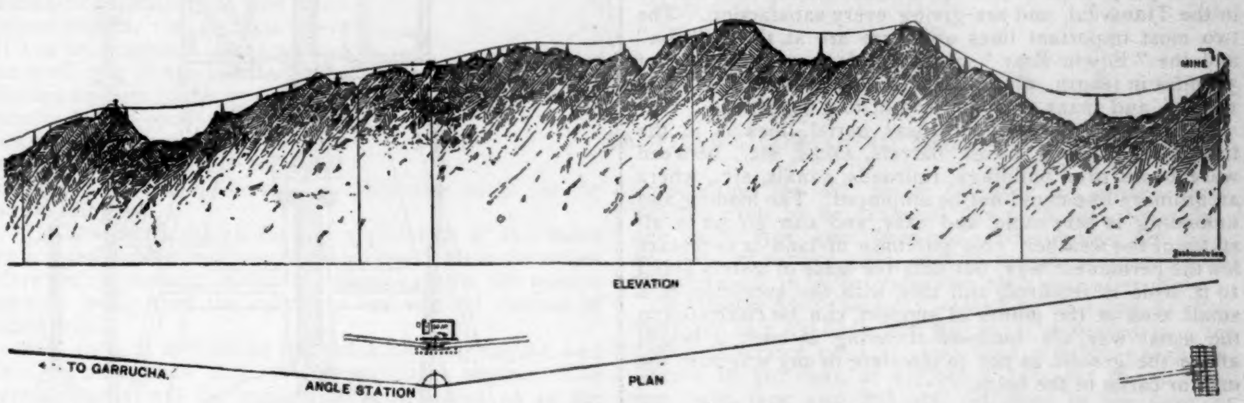


Fig. 17.

bears to the left, passing over more or less hilly country to the second engine house, near Puerto del Coronel, situated at an elevation of 147 ft. From here it again turns to the right, descending at a comparatively easy gradient to the unloading station on the coast, near the town of Garrucha. We should here state that in fig. 17 the horizontal scale is double that of the vertical.

The line, which can be seen from end to end from the mountain ridge between Bedar and Serena, has a very imposing effect—the 660 buckets traveling backward and forward at a velocity of about three miles an hour, appearing smaller and smaller, until in the distance they look only like mere specks, the ropes in the sunlight like silver threads extending to the sea-shore. A spectator cannot help being struck with this system of transport when he sees how steadily and with what precision the carriers move over the deep valleys and steep ridges. The long spans vary from 328 ft. to 750 ft., the average distance of the supports from one another being about 130 ft. The unloading station at the coast is 150 ft. long and 32 ft. above the ground. This permits of 18,000 to 20,000 tons of ore being stored, so as to avoid delay in loading the vessels as they arrive. Electric signals are used, and the stations are connected by telephone.

The transport capacity specified for this line in the original contract was 600 tons per day of 10 hours, but of late, owing to the increased demand for this ore, the line has been working a double shift of 8 hours, and as much as 900 tons a day has been transported to the coast. Notwithstanding the many difficulties that had to be overcome, this line was surveyed and erected ready for use within ten months at a total cost of about $130,000.

There are now over 450 of the Otto ropeways at work in various parts of the world. Several have lately been started in the Transvaal, and are giving every satisfaction. The two most important lines out there are at the "Sheba" and the "Edwin Bray" mines, the former $2\frac{3}{4}$, the latter $3\frac{3}{4}$ miles in length, with gradients in places of 1 in 2 and 1 in 1.6, and spans of from 1,400 ft. to 1,600 ft.

A further application of these aerial lines is in the transport of goods, boxes, barrels, sacks, etc., between warehouses over buildings, railroads, canals, etc., where an ordinary line could not be employed. The loading and unloading is very rapid and easy, and can go on in all states of the weather. No purchase of land is necessary for the permanent way, but only the lease of a strip about 10 ft. wide is required, and this, with the exception of a small area at the points of support, can be cultivated in the usual way, the buckets traveling at such a height above the ground as not to interfere in any way with the men or cattle in the fields.

TESTING RAILROAD MATERIALS.

THE accompanying table, which is taken from the report made to the Master Mechanics' Association by the Committee on Testing Laboratories, shows the work done in the Physical Laboratory of the Chicago, Milwaukee & St Paul Railroad during the year 1890:

	1890.		
Materials.	Amount Received.	Per cent. rejected.	Cost of Tests.
Axles	5,927 axles	5.3	68c. per 100.
Bar iron	4,772 tons	3.9	11.2c. per ton.
Boiler tubes	6,991 tubes	7.2	16.4c. per 100.
Chain	50 tons	3.7	10c. per ton.
Links and pins	722 tons	9.8	6c. per ton.
Springs—helical	20,573 springs	15.2	40c. per 100.
Springs—elliptic	1,839 springs	0.6	$1.50 per 100.
Steel plate	956 plates	7.2	23.4 each.
Track bolts	5,053 kegs	3.8	92c. per 100 kegs.
Track spikes	14,235 kegs	15.5	16c. per 100 kegs.
Wire—barbed fence	6,388 reels	00	8c. per 100 reels.
Turnbuckles	1,260 pieces	00	10c. per 100.
Taps, dies and reamers	384 pieces	5	$3 per 100.

In general the tests show a decrease from former years in the percentage of material rejected, which would indicate increased care on the part of manufacturers.

THE CANFIELD COMPOUND ENGINE.

THE accompanying drawing, fig. 1, shows a vertical compound marine engine, the distinguishing feature of which is a new valve. In this engine a single valve is used to operate the two cylinders, the exhaust from the high-pressure cylinder passing directly to the low-pressure cylinder through the valve itself. There is a single piston rod, to which both pistons are attached, and a single cross-head, the packing between the two cylinders being simple and easily accessible.

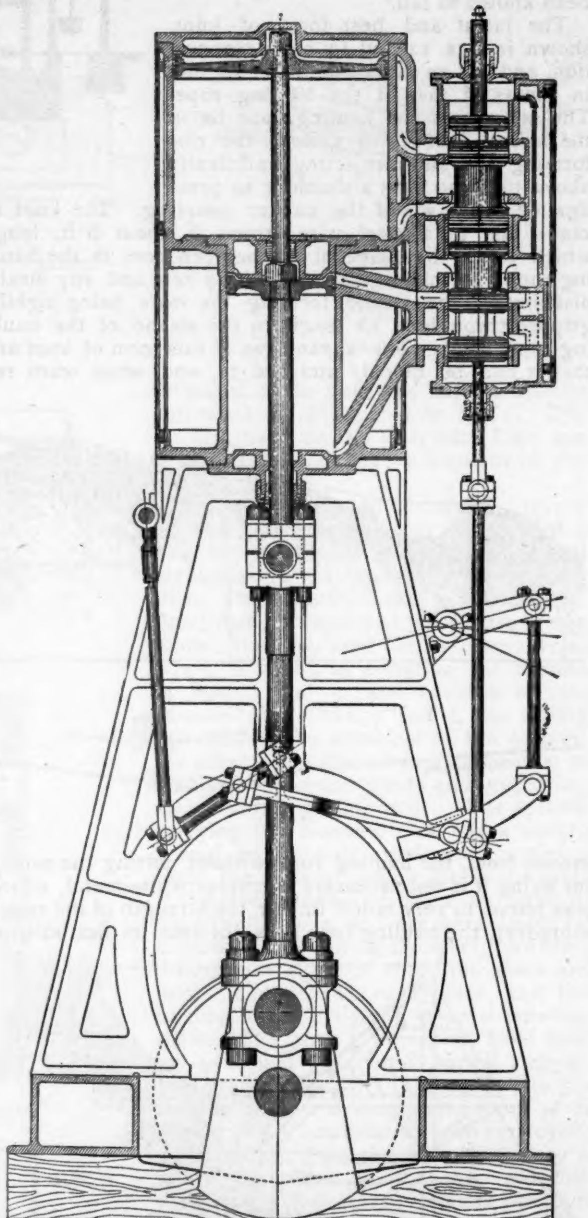


Fig. 1.

CANFIELD'S COMPOUND ENGINE.

The arrangement will be readily understood from the drawing, in which the pistons are shown just at the beginning of the stroke. The exhaust from the high-pressure cylinder passes, as indicated by the arrows, through the port into the steam-chest, then directly through the valve and by the upper port into the large cylinder.

In the engine illustrated the Joy valve gear is used, but

the valve may be operated by any of the usual motions. The advantages obtained in practice have been the relatively high pressure secured in the large cylinder, and the fact that condensation is reduced, the valve being surrounded by steam at high pressure, so that heat absorbed by the valve is passed directly to the steam on its passage to the low-pressure cylinder. In an engine of this kind in use on a tug-boat owned by the Pennsylvania Railroad a considerable gain in power was secured by the use of this valve. Indicator cards taken with an initial pressure of 100 lbs. in the first cylinder, cutting off at five-eighths of the stroke, show an initial pressure of 28 lbs. in the low-pressure, the ratio of the cylinders being 1 : 4. In the engine shown, which is the one referred to, the high-pressure cylinder is 18 in. and the low-pressure 36 in. in diameter.

The valve is fully balanced, the sizes of the valve-stem and tail-rod being so proportioned as to counterbalance the weight of the valve itself by the difference in pressure on the upper and lower ends.

The arrangement is certainly a very simple one, and seems excellently adapted to the compound engine. In the cases where it has been applied it has worked so well that it has been adopted for the engines of the new double-screw ferry-boat *Cincinnati* — which was described and illustrated in the JOURNAL for June last, page 273—and it will be used in other new boats for the same company.

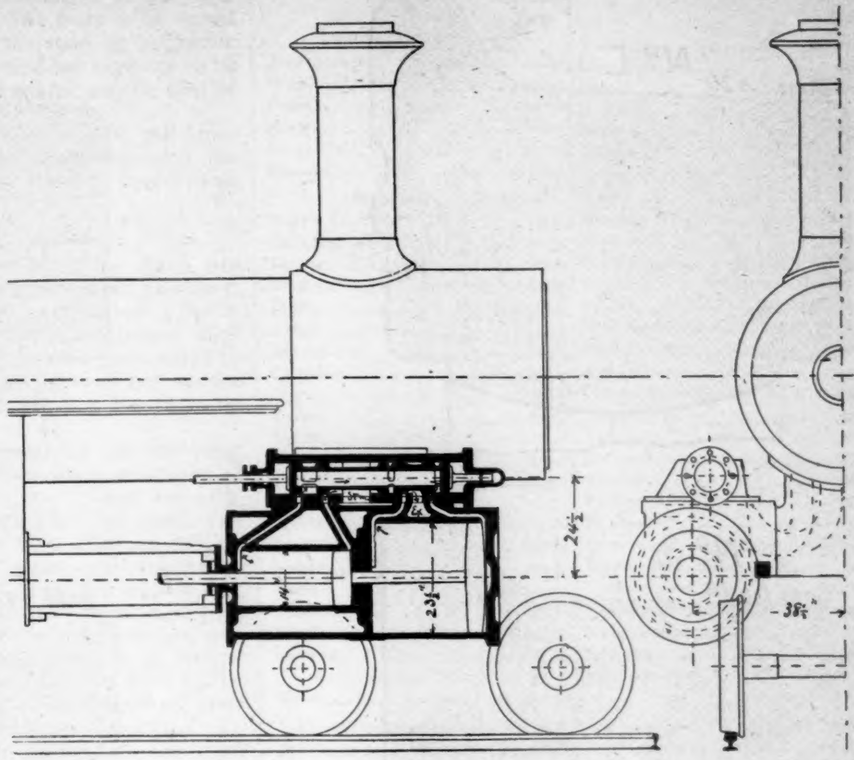


Fig. 2.

CANFIELD'S COMPOUND ENGINE.

Fig. 2 shows a design for the application of this valve to a four-cylinder compound locomotive. Here the cylinders are in tandem, the chief difference from the marine engine being that the cylinders are vertical instead of horizontal.

This valve is well suited to a quick-working engine, and it is to be applied to a vertical stationary engine. The arrangement will be substantially the same as in the marine engine shown in fig. 1. As in that case, it will be free from the objections made to the compound engine of the loss of heat in long connecting pipes and passages, which must be filled at each stroke.

This valve is the invention of Mr. Hobart Canfield, Master Mechanic in charge of the Pennsylvania Railroad repair shops at Hoboken, N. J., where the work on the ferry-boats and other floating equipment of the road is done.

BIDS FOR NEW GUNS.

IN Washington, July 13, in the office of the Chief of Ordnance of the Army bids were opened for 100 new guns. These include 25 of 8-in. caliber, 50 of 10-in., and 25 of 12-in.; all to be breech-loading, rifled, built-up steel guns. Efforts made last year to secure favorable bids failed, and it was necessary for Congress to increase the appropriation for the procurement of these 100 guns to $4,225,000.

The proposals received were as follows:

Midvale Steel Company.—One 8-in. type gun, with ammunition for testing, $22,028, to be delivered in three years; 25 service guns of the same pattern at the same price each, to be delivered in eight years after acceptance of the type gun; one 10-in. type gun, $51,880, and 49 service guns at same price each, to be delivered in eight years; one 12-in. type gun, with ammunition, $88,592, and 24 service guns at the same price each, to be delivered in eight years.

South Boston Iron Works.—One 8-in. gun, $27,300; 350 rounds of ammunition, $24,332; 24 service guns, $20,695 each, deliveries to begin in 1894 and to be made at the rate of six per year; one 10-in. type gun, $60,560; ammunition for the same, $43,350; 49 service guns, $47,700 each, to be delivered five each year after 1895; one 12-in. type gun, $100,000; ammunition for same, $60,000; 25 service guns, with 10 rounds of ammunition, $79,500 each, to be delivered five each year after 1896.

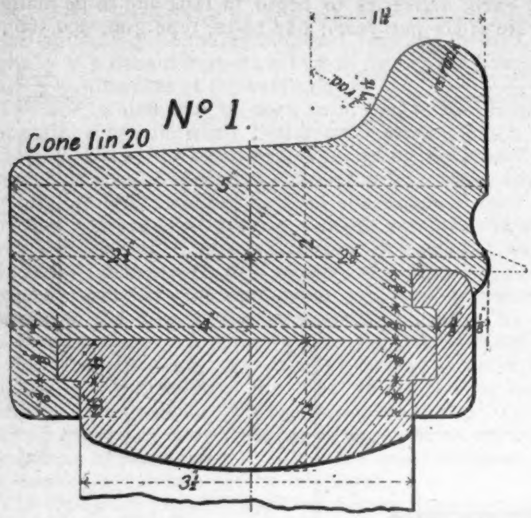
Bethlehem Steel Company.—One 8-in. type gun, $43,893, delivered in 1,460 days, and $42,035 if delivered in 2,190 days; 24 service guns of same kind at $19,723 each, delivered in 552 days, or $17,246 if delivered in 730 days; one 10-in. type gun, $78,937, delivered in 699 days, or $73,755, delivered in 882 days; 49 service guns of this size at $40,929 each, delivered in 2,130 days, or $37,754, delivered in 3,404 days; one 12-in. type gun, $113,951, delivered in 791 days, or $106,558, delivered in 1,095 days; 24 service guns of this size at $61,846 each, delivered in 2,038 days, or $54,473, delivered in 3,194 days.

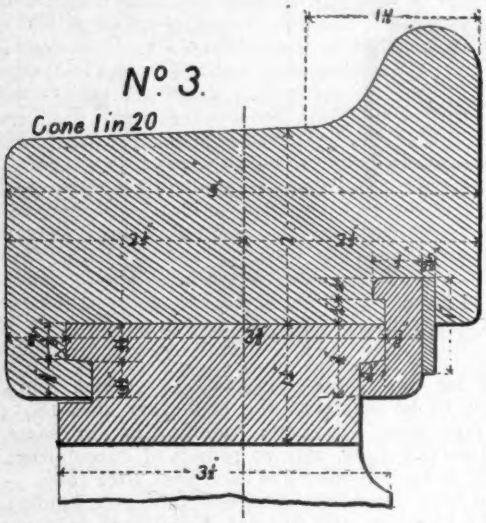
The Bethlehem bid was accompanied by some conditions, one looking to a change in the proportions of the hoops of the guns and another to allowances for advanced deliveries. The act of Congress gives authority to divide the awards, but at their longest periods of time the Bethlehem bids are still the lowest in each class, and their lowest total of $3,785,850 for the 100 guns is the only one within the limit of the appropriation. The total of the Midvale bid is $5,359,500, and of the South Boston bid $5,174,312.

ENGLISH TIRE AND AXLE SPECIFICATIONS.

SOME time since the English Board of Trade called the attention of the General Managers' Committee of the Railway Clearing House to the fact that many cars owned by private parties—coal operators and the like—were not properly built or kept up to the standard required for railroad companies. In accordance with this, a system has been established by which all private cars are required to conform to certain standard specifications, and must pass inspection by some railroad company. Unless this has

been done, and a plate stating the fact attached to a car, it is not allowed to run on any railroad belonging to the





Clearing House. The register-plates are of uniform design, a sample being shown in fig. 6.

From the specifications as prepared and approved by

Fig. 6

the General Managers' Committee, and published by the London *Railway Engineer*, we take the following sections as showing the standards adopted for wheels and axles:

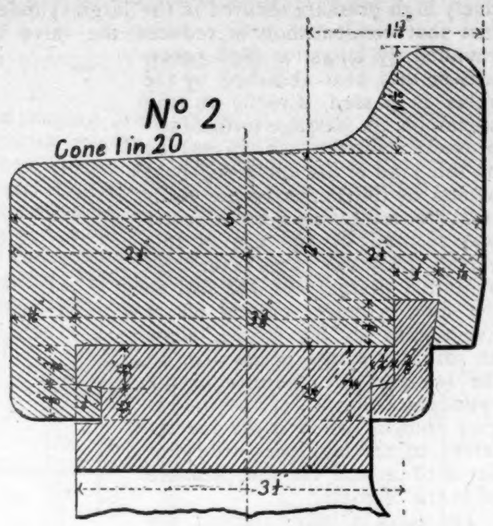
STANDARD WHEELS AND AXLES.

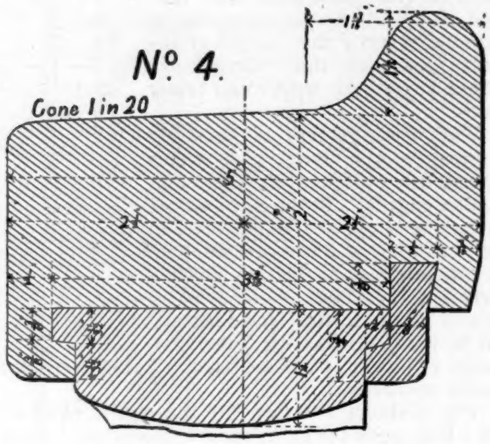
Tires.—13. The tires to be of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 21.

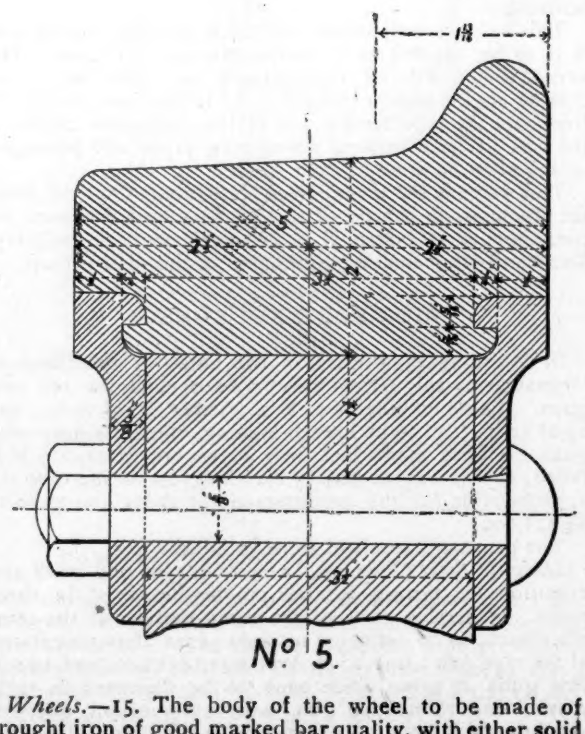
The tires to be 5 in. wide, and not less than 2 in. thick in the middle when finished, truly bored out, with not more than $\frac{1}{16}$ in. for contraction, and secured to the wheels by one of the several approved modes of fastenings shown in the standard drawings (figs. 1, 2, 3, 4 and 5); but neither rivets nor bolts to be passed through or into the tire.

Axles.—14. The axles to be made of Bessemer or Siemens' steel, and to be subjected to the tests set forth in clause 21. Wrought-iron axles may be used if preferred, subject to the tests set forth in clause 22.

The axles to be 6 ft. 6 in. in length from center to center of journals, 5¼ in. diameter through the boss of the wheel, and gradually tapered to 4½ in. in the middle. There must be no shoulder on the axle behind the boss. The journals to be 8 in. long by 3¾ in. diameter, and the whole strictly in accordance with the standard drawing.







N° 5.

Wheels.—15. The body of the wheel to be made of wrought iron of good marked bar quality, with either solid or open spokes, and either wrought or cast-iron bosses.

The bosses to be 7 in. through; those made of wrought iron to be 9½ in. diameter; those of cast iron, 13 in. The rim or periphery to be not less than 1¼ in. thick, soundly welded throughout, and turned exactly to 2 ft. 9 in. diameter, and in section equal in strength to the form shown on the standard drawing. The boss to be bored out, and the wheel forced on to the axle by hydraulic pressure of not less than 30 tons, and no keys are to be used. If preferred, the body of the wheel may be cast of steel of equal dimensions.

Stamping of Ironwork and Steelwork.—16. All Ironwork and Steelwork to be stamped distinctly with the Name or Initials of the Owner, and the day, month, and year when made.

TESTS OF WHEELS AND AXLES.

Testing of Steel Tires and Axles.—21. *A.* Each tire of the diameter of 3 ft. 1 in. to be guaranteed to stand, without fracture, the test of being compressed 4 in. by hydraulic power, the compression to be continued until the tire is broken. Also, each tire must be guaranteed to stand a tensile strain of not less than 35 tons per square in., with 25 per cent. of elongation; the test length to be 3 in.

B. The axles to be capable of standing the following test, without fracture, viz., five blows from a weight of 2,000 lbs. falling from a height of 20 ft. upon the axle, which shall be placed upon bearings 3 ft. 6 in. apart, and turned after each blow. After the fifth blow the axle to be broken. Also, each axle to be guaranteed to stand a tensile strain of not less than 35 tons per square in., with 25 per cent. of elongation; the test length to be 3 in.

C. The maker shall provide, at his own expense, one additional tire and one additional axle in every 50, or any less number ordered, to be selected from the bulk by the inspector, for testing in the manner above described, after which they shall be given up to the buyer, if required.

D. The tires and axles tested to be held to represent correctly the quality of the lots from which they are taken.

E. Each tire and axle to be stamped, while hot, with the day, month, and year when made; and any tire or axle failing before it has run 12 months, to be replaced at the expense of the maker.

F. The maker's name to be well stamped upon each axle, and on the outer edge of each tire.

Testing of Wrought-Iron Axles.—22. *A.* The axles to be capable of standing the following test, without fracture, viz., five blows from a weight of 2,000 lbs. falling from a height of 20 ft. upon the axle, which shall be placed upon bearings 3 ft. 6 in. apart, and turned after each blow. After the fifth blow the axle to be broken.

B. Also each axle to be guaranteed to stand a tensile strain of not less than 22 tons per square in., with not less than 25 per cent. of elongation; the test length to be 3 in.

Rapid Transit in New York.

The engineers of the Rapid Transit Commission have been making a series of borings to ascertain exactly the nature of the ground through which the underground line proposed by the commission is to be built. It is stated that the results are very satisfactory. The formation through which the proposed tunnel road is to be constructed is peculiarly susceptible to tunneling. The soil is sandy all along the line, fine red in quality from the Battery to Chambers Street, with now and then a stratum of coarse grit. North of Chambers Street the sand is coarse and gritty, impregnated with gravel very thickly at Canal and Broome streets, and with occasional drifts of fine red sand.

The construction of the road will undoubtedly be by means of a shield, and there is found no obstruction to its use along the entire line through the business section of the city, from the Battery to Eleventh Street. The excavation can be done and the tunnel constructed without any blasting operations whatever and without doing anything that will interfere with the foundations of buildings, except at Twenty-seventh Street, where private property will have to be acquired. The results have been so surprising with respect to Canal Street and Duane Street that the engineers have ordered proof borings to be made at these points, without, however, having any reason to expect a different result. The record, which will be esteemed of value as a reference by property owners in Broadway, is given herewith in its entirety. It is the record of the first scientific exploration of subterranean Broadway that has been made:

	Feet to Bed Rock.
Whitehall Street.	
Front Street	20.00
Water	23.00
Pearl	16.00
Bridge	20.00
Stone	21.00
Beaver	34.00
Broadway.	
Morris	35.25
Exchange Alley	51.50
Rector	63.10
Wall	60.10
Pine	70.00
Cedar	70.75
Liberty	70.90
Cortlandt	70.30
Dey	76.85
Fulton	83.25
Vesey	81.50
Barclay	101.15
Park Place	112.50
Murray	113.50
Warren	109.20
Chambers	100.75
Reade	116.00
Duane	163.50
Thomas	138.50
Worth	147.50
Leonard	96.55
Franklin	83.45
White	105.50

	Feet to Bed Rock.
Walker	107.20
Lispenard	68.25
Canal	87.65
Howard	50.00
Grand	70.80
Broome	47.75
Spring	70.10
Prince	70.00
Houston	105.60
Bleecker	66.15
Bond	68.85
Third	53.00
Fourth	40.10
Washington Place	34.55
Waverly Place	48.85
Astor Place	49.75
Clinton Place	65.25
Ninth	35.25
Tenth	40.33
Eleventh	31.15
Twelfth	22.00
Thirteenth	34.00
Fourteenth	13.35
Seventeenth	10.15
Twenty-first	17.00
Twenty-third	21.50
Twenty-fifth	24.00
Twenty-seventh	19.20
Thirtieth	15.00
Thirty-third	4.00

Deep depressions in the bed rock are noted at Duane Street, at White and Walker streets, and at Houston Street. But the satisfactory feature of the showing is that rock excavation will be required only through Whitehall Street and from Eleventh Street northward. All the sub-surface works lie within 8 ft. of the street grade. The tunnel construction need not begin any deeper than 10 ft. below the surface, and will occupy a space below that of only about 20 ft. For the purpose of the tunnel, therefore, 30 ft. of soil above bed-rock will be sufficient. At no place between Beaver and Eleventh streets is there a less depth than 34 ft.—*New York Times.*

THE ESSENTIALS OF MECHANICAL DRAWING.

By M. N. Forney.

(*Continued from page* 324.)

CHAPTER XII.

PROJECTIONS.*

In representing different views of an object it is often convenient or essential to extend or "project" lines from one view to define the position of the parts in another view. Some simple methods of doing this were explained in Chapters IV. and V. In this chapter some of the more difficult principles and methods of representing different views of mechanical objects will be explained.†

PROJECTIONS OF A CUBE.

Fig. 280 is a perspective view of a cube, the sides of which are all 1 in. × 1 in. The top is numbered 1, its sides 2, 3, 4, and 5, and the bottom 6, so that the different views may be easily identified.‡ The edges and figures, which are hidden from view, are represented by dotted lines.

* In treating this branch of mechanical drawing, very free use has been made of "The Engineers' and Machinists' Drawing Book," published by Blackie & Son, of London and Edinburgh, but which is now out of print. Some of this chapter and some of the engravings in it have been taken from that book.

† The student should draw the exercises given in this chapter twice the size of the engravings.

‡ This is not a true perspective view, but for the present purpose it will answer our purpose better than a correct view would, as the length of all the sides is of the correct dimension, or 1 in.

PROBLEM 103. *To draw projections of a cube.*

To represent a geometric view of the front side, 2, we should draw a square, as represented by *a b c d* in fig. 281. To represent a view of the right-hand side, 3, we can extend or "pro-

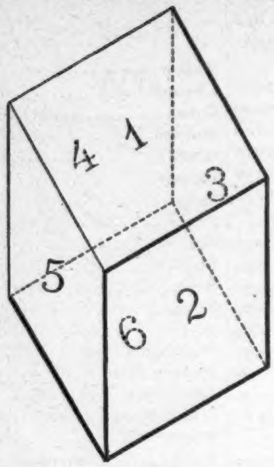


Fig. 280.

ject" the line *a b*, which forms the upper side of the front view, toward the right, and the projection *e f* of this line will then represent the upper edge of the right-hand side view. In the same way the lower edge *d c* may be projected toward the right, and both *a b* and *d c* may both be projected toward the left to delineate the side view of the left-hand side, 5; *e g, f h, i k* and *j l* can then be laid down, and the views of the right and left-hand sides of the cube are then completed. In a similar way the sides *a d* and *b c* may be projected above and below the front view to represent the plan 1 and inverted plan 6.* This is all very simple, and although it facilitates the drawing of the different views yet their dimensions could readily be laid down without projecting the lines of one view to represent another.

PROBLEM 104. *To draw projections of a cube which is standing on one of its edges.*

Let it be supposed that the cube is standing on one edge, as shown in the front view, 2, fig. 282. To represent either side view it is essential, in order to fix the positions of the edges *e f, w x, k l* and *i j*, to project lines from *a* to *w x* and *i j*, from *b* to *e f*, and from *d* to *k l*. This is also true of the plan and inverted plans, and in drawing these the positions of the vertical lines *y z, p o, n m, q v, s t* and *u v* can only be determined by projecting lines from *a b c* and *d*.

The drawing of a hexagonal bolt head or nut, explained in Chapter V., is another illustration of the application of the principle of projecting one view from another.

PROJECTIONS OF A PYRAMID.

PROBLEM 105. *To draw a projection of a pyramid.*

On inspecting figs. 283 and 284, it will be seen that two distinct geometrical views are needed to convey a complete idea of the form of the object—namely, a side view or elevation, fig. 283, to represent the sides of the body, and to express its height; and a plan of the upper surface, to show the form as seen in looking down on it from above.

It should be observed that this body has an imaginary axis or center-line, *S G*, about which the same parts are equally distant. A figure of this kind, or one which may be supposed to consist of two halves of the same form joined together, is said to be *symmetrical.* A prism, fig. 289, or a cone, fig. 295, for instance, may be cut in two halves through its axis or center line, and each part will be of the same form. This is also true of a pyramid.

To represent a pyramid, in the first place, a horizontal straight line *L R*, fig. 283, should be drawn. This line will represent what may be called the *ground-line* or base on which the pyramid rests. Then draw a perpendicular *S G* to this base and extend it below *L R*.

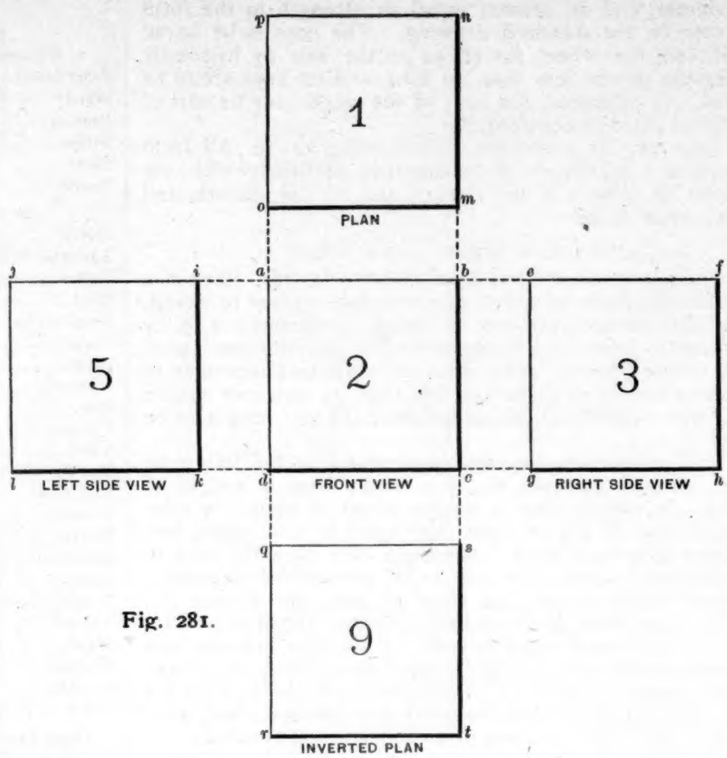


Fig. 281.

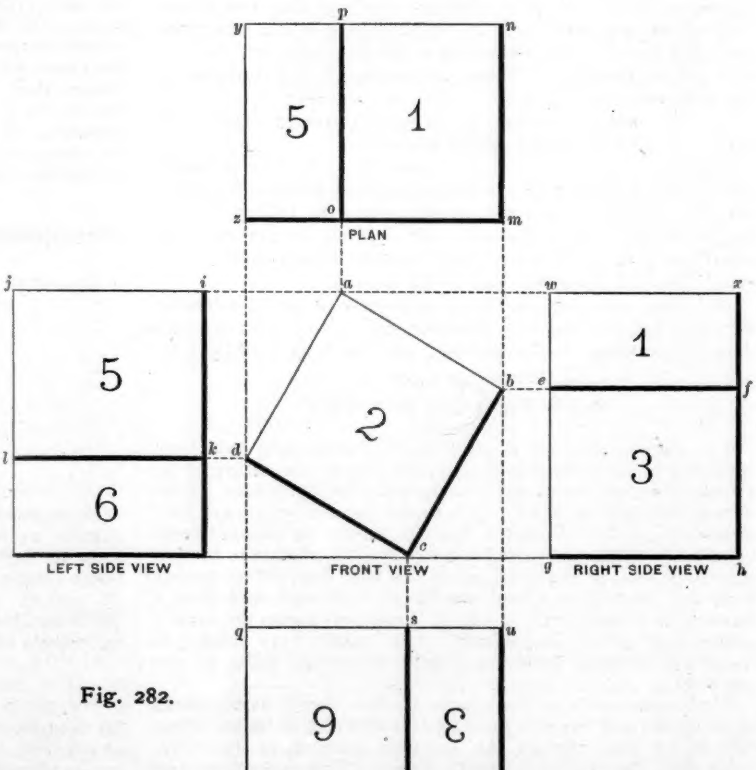


Fig. 282.

The plan or top view of the pyramid should then be drawn. To do this take any convenient point as *S'* below *L T*, and, if the pyramid is hexagonal, draw a hexagon *A' B' C' D' E' F'* about the point *S'*. The methods of doing this were described in Chapter III. The most convenient way is to draw a circle

* It will be observed that the 6 in fig. 280 is shown upside down in fig. 281.

from the center S', whose diameter $a\ b$ is equal to that of the base of the pyramid measured over its sides. Then with a T-square and a 30° and 60° triangle draw the sides of the hexagon tangent to the circle. This hexagon will represent the base of the pyramid.

Then from G lay off a distance $G\ S$ equal to the height of the pyramid. In order to show the position of the corners of the base in the side view, fig. 283, draw perpendicular lines $A'\ A$, $B'\ B$, $C'\ C$, and $D'\ D$ from the corners $A'\ B'\ C'$ and D', intersecting the horizontal line $L\ R$ at A, B, C and D. These points will represent the position of the corners or angles of the base of the pyramid in fig. 283. As the sides of all unite in a common point S, called the *vertex*, by drawing lines $A\ S$, $B\ S$, $C\ S$ and $D\ S$ joining the angles A, B, C and D with S, they will represent the intersections of the sides, and will complete the side view of the figure.

To complete the plan, draw lines from the angles $A'\ B'\ C'$—F' to the center S'.

PROBLEM 106. *To draw the same pyramid, having its base A D, fig. 285, in an inclined position to the ground-line, but with its edge, B C, fig. 285, parallel to the vertical plane or the surface of the paper.*

It is evident that, with the exception of the inclination, the side view of the pyramid will be the same as in the preceding example,

Fig. 283.

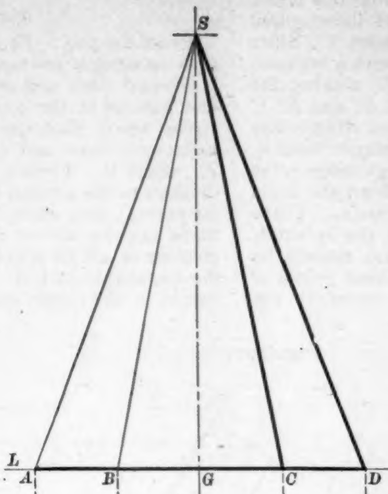
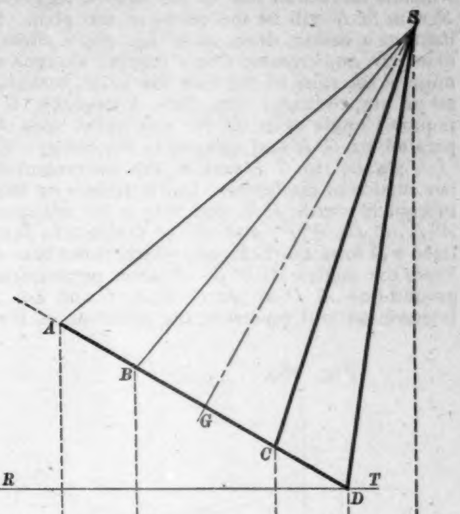


Fig. 285.



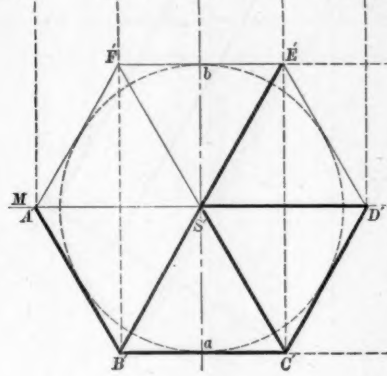


Fig. 284.

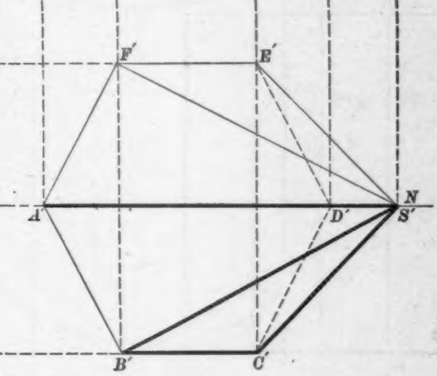


Fig. 286.

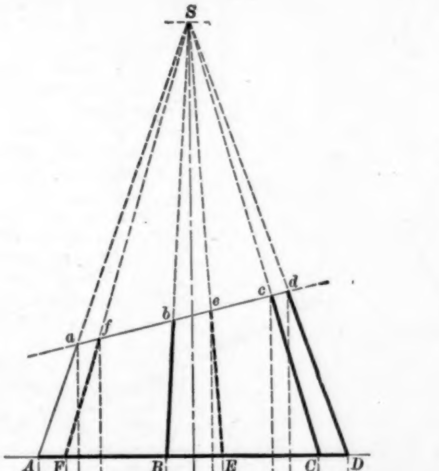


Fig. 287.

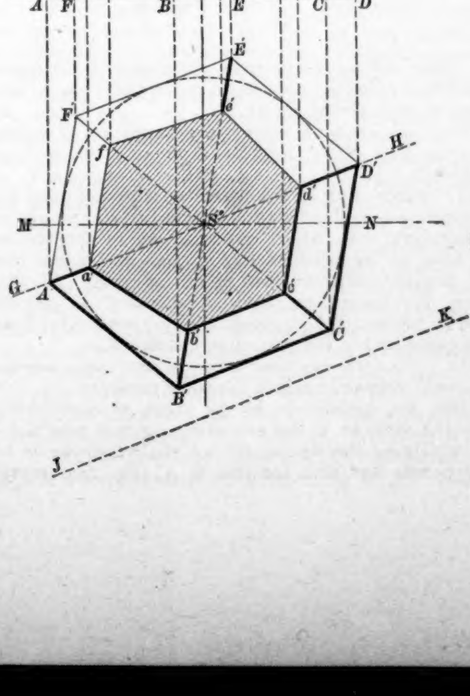


Fig. 288.

and it is therefore only necessary to copy fig. 283. For this purpose, after having fixed the position of the point D upon the ground-line $R\ T$, draw through this point an indefinite straight line $D\ A$, making with $R\ T$ an angle equal to the desired inclination of the base of the pyramid. Then with a pair of dividers take from fig. 283 the distance $G\ A$ or $G\ D$, equal to half of the base, and lay it off from D, in fig. 285, to G, and from G lay off the same distance $G\ A$; then $D\ A$ will represent the base of the inclined pyramid. As the axis must still, as in the former case, pass perpendicularly through the center of the base, the line $G\ S$ should be drawn through G and perpendicular to $A\ D$. From G lay off the height $G\ S$ equal to the height of the pyramid. Then take the distance $C\ D$ or $A\ B$, from fig. 283, and lay it off from D and A, in fig. 285, to C and B, which will be the positions of the angles of the base. Unite these angles with the vertex S by lines $A\ S$, $B\ S$—$D\ S$ and the side elevation of the pyramid will be completed.

If the plan, fig. 286, of the inclined pyramid is drawn on the same center line $A'\ S'$ on which fig. 284 is represented, draw from D, fig. 285, a perpendicular line $D\ D'$; then D' will represent the position in the plan of the corner or angle D on which the pyramid rests. In the same way draw a perpendicular from A intersecting $A'\ S'$ at A', and this will represent the position of the angle A in the plan. As the sides $F'\ E'$ and $B'\ C'$ are supposed to be parallel with the horizontal center line $M\ N$, those sides may be most conveniently drawn by projecting the lines $F'\ E'$ and $B'\ C'$, of fig. 284, to fig. 286. Then from the angles B and C, of fig. 285, draw perpendiculars $B\ F'\ B'$ and $C\ E'\ C'$ intersecting $F'\ E'$ and $B'\ C'$; then $F'\ E'$ and $B'\ C'$ will represent the positions of the angles of the base in the plan, and the sides $A'\ B'$, $C'\ D'$, $D'\ E'$ and $F'\ A'$ may be drawn to complete the base. The position of the vertex S, in fig. 286, may be determined by drawing a perpendicular from S intersecting $M\ N$ at S'. Then by uniting the angles $A'\ B'\ C'$—F', in fig. 286, with lines drawn to S' the plan will be completed.

PROBLEM 107. *To draw a side view of a pyramid none of whose sides are parallel or perpendicular to a straight or perpendicular line.*

Having drawn, as before, the vertical $S S'$, figs. 287 and 288, which is the center line of the figures, its point of intersection S' with $M N$ will be the center of the plan. From this point, then, as a center, draw, as in fig. 284, a circle of the required diameter, and circumscribe a regular hexagon about it. Since none of the sides of the base are to be parallel with a horizontal or perpendicular line, draw a diameter $G H$, making the required angle with $M N$, and draw lines $F' E'$ and $B' C'$ parallel to $G H$ and tangent to the circle. Then draw a line $J K$ parallel to $G H$ and at any convenient distance from it, but outside of the figure. Lay a triangle or straight edge so as to coincide with $J K$, and with a 60° triangle draw the sides $A' B'$, $C' D'$, $A' F'$, and $E' D'$ tangent to the circle. These lines will form the hexagon, which is the base of the pyramid. From the angles $A' B' C'—F'$ erect perpendiculars cutting the ground-line $A D$ at A, F, B, E, C and D. These points of intersection will represent the positions of the corners of the pyramid in the side elevation. From the ground-line lay off the height of the pyramid to S, and draw lines $A S$, $B S$, $C S$, and $D S$ and the side view will be completed.

PROBLEM 108. *To draw the plan of a transverse section of a pyramid, made by a plane cutting it at an angle to its perpendicular.*

If the cutting plane is represented by the line $a d$, fig. 287, in the elevation, it is obvious that it will expose, as the section of the pyramid, a polygon whose angular points will be at the intersections of the various edges or corners of the pyramid with the cutting plane—that is, the point where the plane $a d$ intersects the side $S D$ must be on the line $a d$, in fig. 287, and on the line $S' D'$, in fig. 288. Consequently by drawing a perpendicular $d d'$ from d intersecting $S' D'$ at d', then d' will represent in the plan the point of intersection of the plane with the corner $S' D'$. By drawing other perpendicular lines from c, e, b, f and a intersecting $S' C'$, $S' B'$, etc., at c', b', etc., the position of all the angles of the intersecting polygon $a' b' c' d' e' f'$ will be determined. By uniting these angles by straight lines $a' b'$, $b' c'$, etc., they will form the outline of the polygon which represents the plan of the intersection of the cutting plane with the pyramid.

PROJECTION OF A PRISM.

PROBLEM 109. *To represent a regular six-sided prism, which is in an upright position, in a side view and plan.*

Ground lines and center lines should be drawn, in figs. 289 and 290, as in the previous examples. Then from S' draw a circle whose diameter is equal to the short diameter of the hexagonal base, and circumscribe a hexagon $A' B' C' D' E' F'$ about it. Project the base thus delineated by perpendiculars to the ground-line $G K$, fig. 289, from each of its angular points; and since the prism is upright, it is obvious that these angular points themselves represent the horizontal projections of all its edges, and that their elevations coincide with the perpendiculars $A' G$, $B' H$, etc. Set off from G to A the height of the prism, and through A draw $A D$, parallel to the ground-line. This will be the vertical projection of the upper surface. The edges being all parallel to the vertical plane, are, of course, seen in their actual length.

Fig. 289. Fig. 291. Fig. 293.

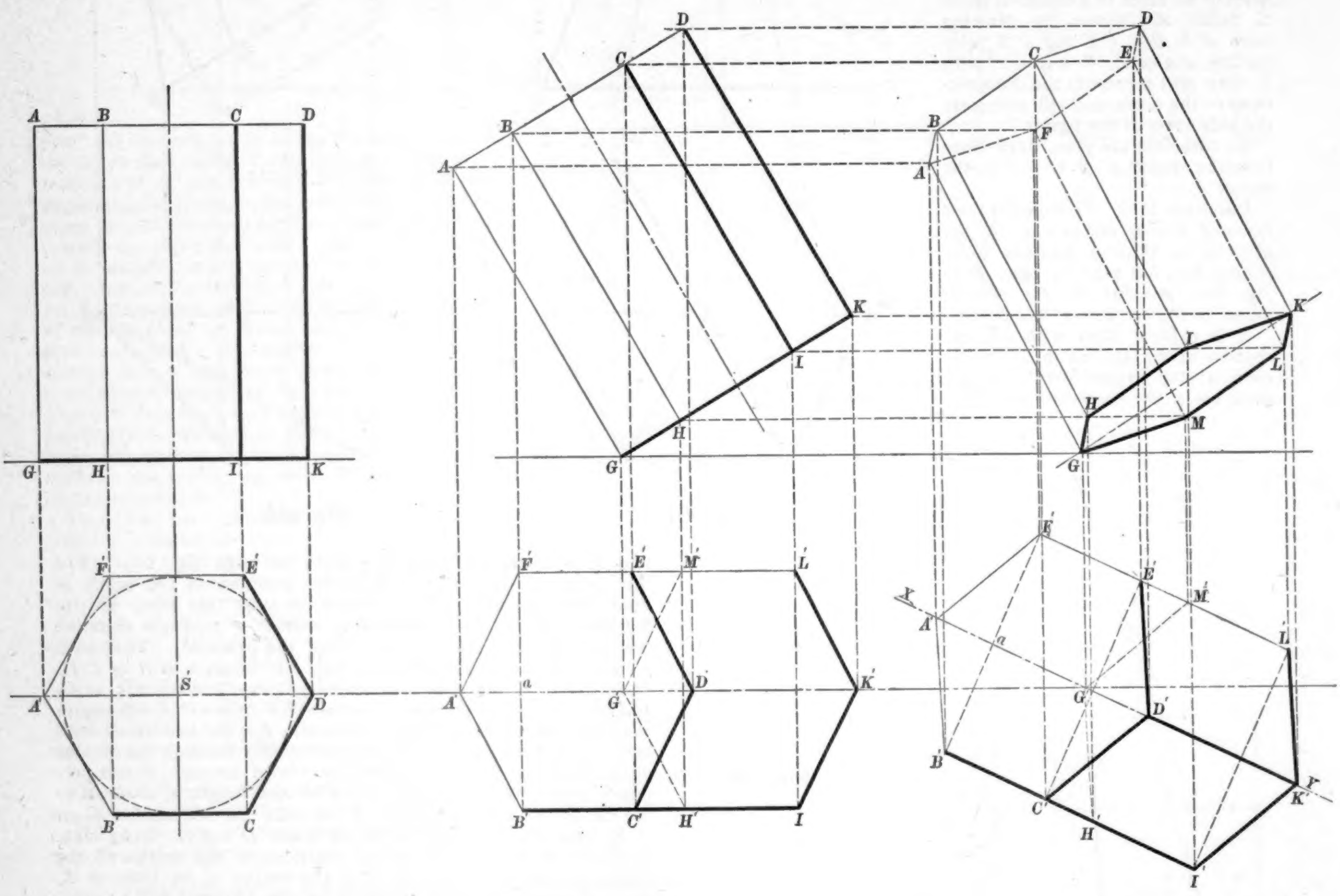


Fig. 290. Fig. 292. Fig. 294.

PROBLEM 110. *To draw the same prism, supposing it to have been turned on the point G, fig. 291, and to stand in an inclined position, as shown.*

The method of proceeding in this case is so similar to that explained in drawing an inclined pyramid that little explanation is needed excepting that which the engravings themselves afford. The view of the prism in fig. 291 is exactly like that shown by fig. 289, the position alone being different. All that is needed, then, is to draw it on the inclined base $G K$, and the plan may then be constructed by projecting perpendicular lines downward, as explained in the preceding examples.

PROBLEM 111. *To draw the same prism in two views when it is inclined in two directions or to both planes of projection.*

Assuming that the inclination of the prism upon the horizontal plane is the same as in the preceding figures, which, for the sake of simplifying the operation, we shall suppose to be already constructed, and that the line $G K$, fig. 293, repre-

sents the inclination of the base to a horizontal plane, and that the line $X\ Y$, in fig. 294, represents its inclination to a vertical plane. The first process, then, is to copy fig. 292, and draw it on the center line $X\ Y$. To do this, first set off upon this line a distance $A'\ G'$ equal to $A'\ G'$ of fig. 292; transfer the distances $G'\ K'$ and $D'\ K'$ from fig. 292 to fig. 294; and, in order to find the remaining angular points, make $A'\ a$ equal to the corresponding distance in fig. 292, and through a draw $B'\ F'$ perpendicular to the center line, and transfer the distances $a\ B'$, $a\ F'$. Through the points B' and F' draw straight lines parallel to $A'\ K'$, and join $A'\ B'$, $A'\ F'$; and since we have already seen that all the other sides of the polygon must be parallel to one of these two, the figure may be completed by drawing through the points $G'\ D'$ and K' straight lines parallel to $A'\ B'$ and $A'\ F'$ respectively.

Now, since the prism has been supposed to have preserved its former inclination to the horizontal plane, it is obvious that every point in it, such as A, fig. 293, has, in assuming its new position, simply moved in a horizontal plane, and will, therefore, be in the line $A\ A$ drawn from A, of fig. 291, and parallel to the ground-line, and since the same point has been projected to A', fig. 294, it will also be in the perpendicular $A'\ A$ drawn from A', in fig. 294; the point of intersection A, fig. 293, is, therefore, the projection of A' in the elevation or side view. The remaining angular points, in this view, are all determined in the same manner—that is, by projecting horizontal lines from fig. 291 and vertical ones from fig. 294; and then joining the contiguous points and the corresponding angles of the upper and lower surfaces, we obtain the complete vertical projection of the prism in its doubly inclined position.

Fig. 297.

Fig. 295.

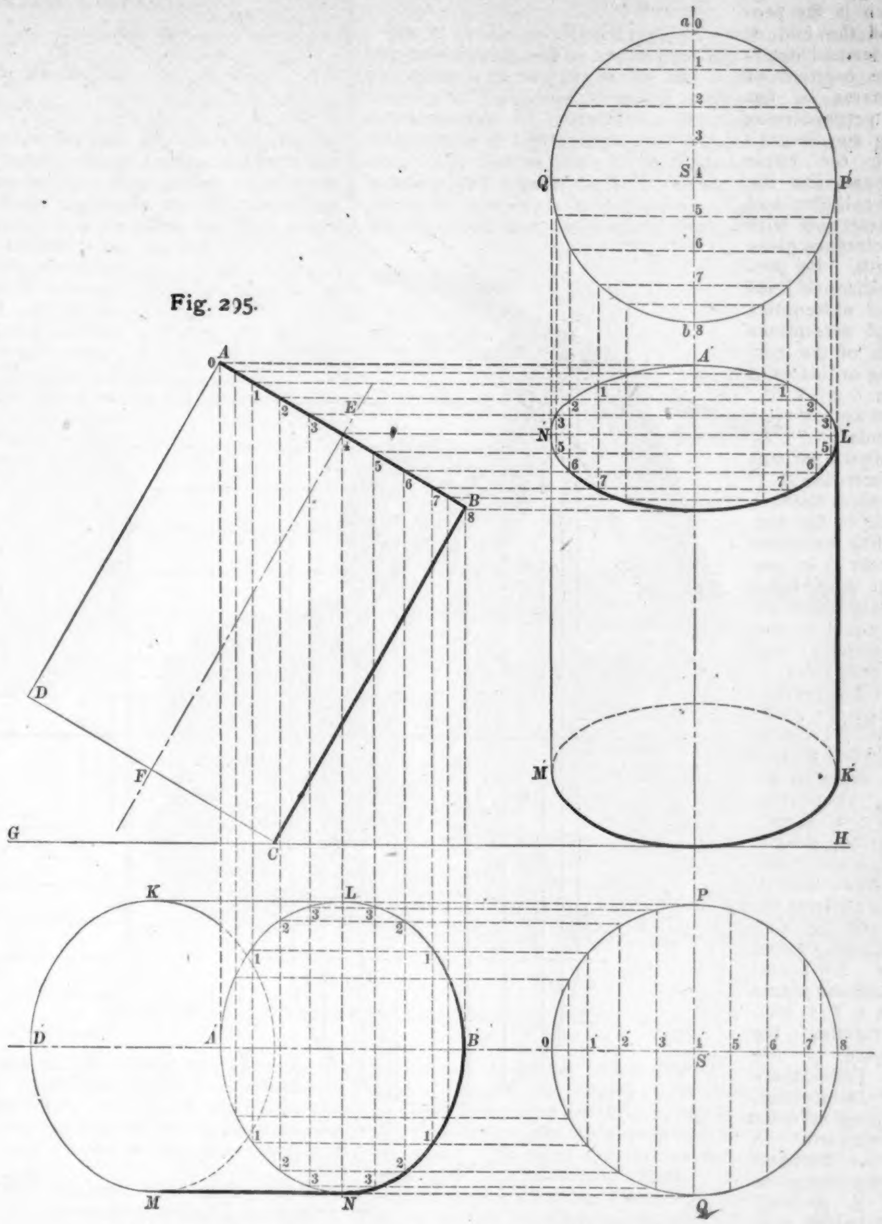


Fig. 298.

Fig. 296. Fig. 299.

PROBLEM 112. *To draw a side view, plan and end view of a cylinder whose axis is inclined to a horizontal plane.*

Let $A\ B\ C\ D$, fig. 295, represent a side view of a cylinder the axis $E\ F$ of which is inclined to the horizontal plane $G\ H$. To draw the plan, fig. 296, first draw a center line $D'\ B'$ parallel to $G\ H$, and at any convenient distance below it. Then from the corners $A\ B\ C$ and D of the cylinder draw perpendiculars to $D'\ J$. These will define the length of the cylinder in the plan. Next take a center S' on $D'\ B'$ extended, and with a radius $S'\ P$ equal to $D\ F$, half the diameter of the cylinder, describe a circle which will represent the end of the cylinder. From the top P and bottom Q of this figure project horizontal lines $P\ L\ K$ and $Q\ N\ M$; then $L\ K$ and $N\ M$ will define the sides of the cylinder in fig. 296. To represent the outline $L\ A'\ N\ B'$ of the end of the cylinder subdivide the line $A\ B$, which represents the top of the cylinder in fig. 295, into any number of equal parts 1, 2, 3, etc., in this case eight, and draw perpendiculars down from the points of division intersecting $D'\ B'$. Next subdivide the diameter $O\ J$ of the circle represented by fig. 299 into the same number of equal parts, as $A\ B$, fig. 295, has been divided into, and draw perpendiculars to o 8′ through these points and intersecting the circumference of the circle. From the points of intersection project horizontal lines cutting the perpendiculars which have been drawn through 1, 2, 3, etc., of fig. 295. The points 1, 2, 3, etc., when these two sets of lines intersect each other, in fig. 296, will be points in the curve which will represent the projection of the end of the cylinder in the plan, fig. 296. It should be explained that the projection of a circle which is inclined to the plane on which it is represented is always an ellipse. The curve $L\ A'\ N\ B'$ drawn through the points 1, 2, 3, etc., can, therefore, be drawn in the manner explained in Chapter XI. The curve $K\ D'\ M$, representing the other end of the cylinder, may be drawn in the same way by subdividing the line $D\ C$, which represents the lower end of the cylinder, and projecting lines down to $D'\ B'$. As the ellipse, which represents the lower end of the cylinder in the plan, will be exactly like that which shows the upper end when the one has been delineated, the other may easily be repeated when its length and breadth are defined.

The explanation of this method of drawing the projection of the circle, which represents the end of the cylinder, is that the perpendicular lines drawn from the divisions 1, 2, 3, etc., of fig.

295, represent ordinates of the ellipse in fig. 296, which is the projection of the end of the cylinder and determines the position of the ordinates in fig. 296. The perpendicular lines in fig. 299 are ordinates of the circle which represents the end of the cylinder, and their intersection with the circumference gives their length. By projecting horizontal lines from their extremities to fig. 296 determines the length of the corresponding ordinates of the ellipse $L\ A'\ N\ B'$.

To draw an end view of the cylinder $A\ B\ C\ D$, first lay down a perpendicular center line $A'\ P$ at a convenient distance on one side of fig. 295. On this line extended with a center S in any convenient position draw a circle whose diameter is equal to that of the cylinder, and from the two sides P' and Q' project perpendicular lines $P'\ L'\ K'$ and $Q'\ N'\ M'$ downward. These will represent the sides of the cylinder. Then from the points 1, 2, 3, etc., on $A\ B$, fig. 295, project horizontal lines crossing the center line $A'\ P$. Next subdivide the diameter $a\ b$, fig. 297, into eight equal parts, and draw horizontal lines through the points of division 1, 2, 3, etc., and intersecting the circumference of the circle. From these points of intersection project perpendicular lines downward, to intersect the horizontal lines drawn from the points 1, 2, 3, etc., of fig. 295, to fig. 298. The points 1, 2, 3, etc., where the corresponding perpendicular and horizontal lines intersect each other in fig. 298, will be points in the curve which represents the end view of the top of the cylinder.

Fig. 305.

Fig. 300.

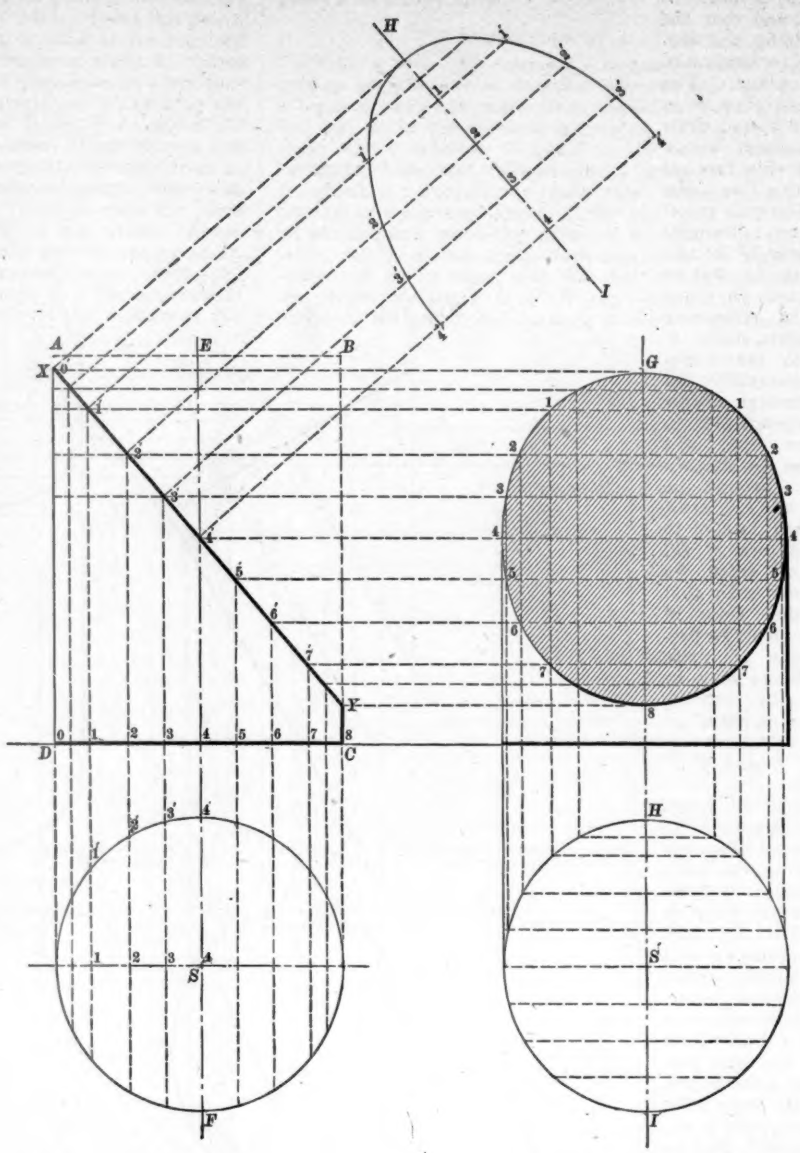


Fig. 303.

Fig. 301.

Fig. 304.

In making such projections it will often be well to subdivide some of the divisions, as 0 1 and 7 8, in figs. 295 and 297, through which projecting lines are drawn in order to get more points in some parts of the curve to be laid out. The circle shown in fig. 299 would answer for laying out both figs. 296 and 298 by subdividing the diameter $P\ Q$, of fig. 299, the same as $a\ b$ of fig. 297, and drawing horizontal and vertical projection lines to fig. 298; but in the engravings separate circles for each view have been represented to avoid confusion.

PROBLEM 113. *Given the side view of a cylinder $A\ B\ C\ D$, fig. 300, and the direction of a plane, $X\ Y$, cutting it obliquely to a horizontal plane; required to find first the horizontal projection of this section; and, secondly, the outline of the section thus formed.*

First subdivide the base $D\ C$ of the cylinder into any number of equal parts, 1, 2, 3, etc., eight in this instance, and draw perpendicular lines through these points and intersecting the plane $X\ Y$. On the right side of fig. 300 draw a vertical center line $G\ H\ I$, fig. 303, and on this center line below fig. 303 take a center S' and draw a circle, fig. 304, whose diameter is equal to that of the cylinder. Subdivide the vertical diameter $H\ I$ of this circle into the same number of equal parts as the base $D\ C$ has been divided into, and draw horizontal lines through the points of division cutting the circumference of the circle. From the points of intersection draw vertical lines upward and from the points 1', 2', 3', etc., in the cutting plane $X\ Y$, fig. 300, draw horizontal lines intersecting in fig. 303 the vertical lines drawn from fig. 304. The points of intersection 1, 2, 3, etc., in fig. 303, will be points in the outline of the horizontal projection of the section $X\ Y$.

In this view it will be observed the section is foreshortened. To represent the correct form of the section, draw a center line $H\ I$ at some distance from $X\ Y$ of fig. 300, and parallel to it. From the points, 1', 2', 3', etc., in the plane $X\ Y$, draw lines perpendicular to it and intersecting $H\ I$. On the center line $E\ F$, extended below fig. 300, take a center S and draw a circle, fig. 301, of a diameter equal to that of the cylinder. Extend the vertical lines which are drawn through the points 1, 1', 2, 2', 3, 3', etc., so as to cut the circumference of the circle, fig. 301. From this figure take with dividers half the length 1 1' of the vertical line included within the circle and set it off from the center line $H\ I$, in fig. 305, on the line drawn through 1', in fig. 300. Similarly take the distance 2 2' from fig. 301, and set it off in fig. 305 on the line drawn through 2' of fig. 300. In the same way points may be laid off on the other lines in fig. 305, and these will be points in the outline of the section $X\ Y$, which can then be drawn through these points.

In fig. 305, in order to save space and avoid confusion, only one half the outline of the section is represented.

(TO BE CONTINUED.)

Manufactures.

A New Hand-Car.

THERE is no doubt that within the past few years greater attention has been paid to the smaller devices connected with the maintenance of way department than ever before. On most roads economy has been made necessary by the prevailing conditions of railroad operation, and the effort has been to reduce the number of men required in every direction as much as possible. The average section gang on a railroad is now much smaller than it used to be, and it is consequently an object to reduce as much as possible the work which they are obliged to do. One of the principal tools of a section gang is the hand-car. The weight of this was not a particular object when the gang consisted of from 8 to 12 men, but when it was reduced to half that number, to find a car which can be easily handled by two or three men was certainly an object. The accompanying illustration shows a car which has been built to meet these conditions; to furnish one which can carry all that is usually necessary and at the same time can be easily lifted from the track by one or two men when it is necessary to remove it.

The greatest problem in the construction of such a car is to get a light and durable wheel. A cast-iron wheel is too heavy. The wheel with cast hub and rim and wrought spokes is not usually durable, the spokes very soon getting loose. A wood-center wheel has been tried and proved to be satisfactory, but is regarded by some railroad officers as not as strong or as durable as one entirely of metal. The wheel which is shown in perspective in the view of the hand-car and in section in fig. 2 is made from a circular plate of steel, which is brought to the desired shape by a series of operations. It is furnished with a turn-over flange, making a flange of sufficient thickness to run over and through furnaces and switches safely. It is cut away in the center after having corrugated, the corrugations adding to its strength and the cutting away reducing the weight. The hub and flange are of drop-forged steel, and are riveted to the center. The wheel appears to be strong and at the same time light, and to have the qualities required in a hand-car wheel, while at the same time it is free from the objections which have been mentioned above, and from those which have been brought forward against the wood-center wheel. Of course, it would be well adapted not only to hand-cars but for other kinds of light work, such as contractors' cars, mine cars, and similar vehicles. It may be noted, at the same time, that this wheel and the processes by which it is manufactured are a good illustration of the progress which has been made in recent years in the methods of forming and shaping steel.

This hand-car and wheel are made by the Sheffield Velocipede Car Company of Three Rivers, Mich., whose work of this class is well known.

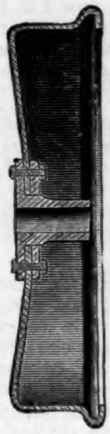


Fig. 2.

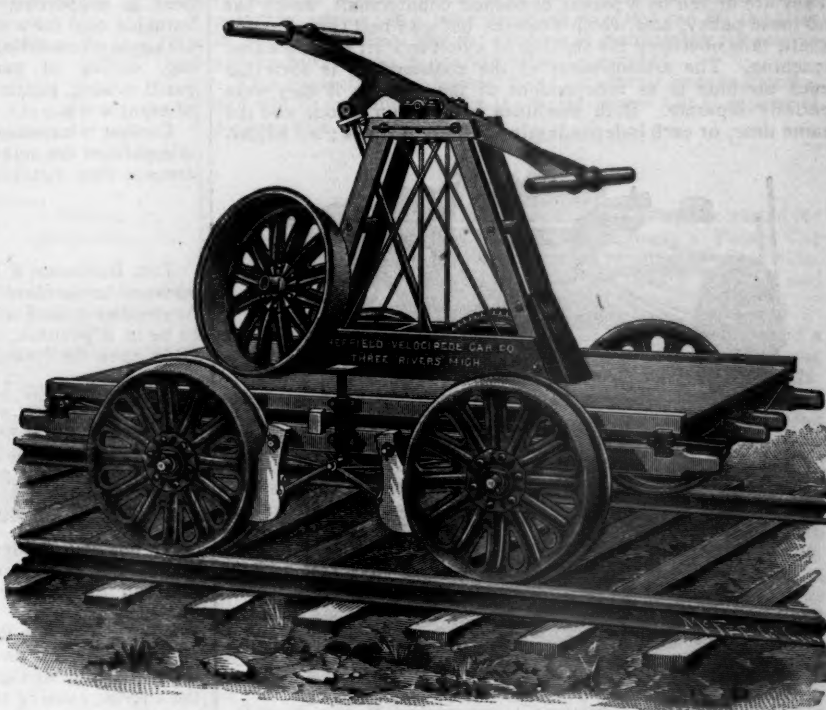


Fig. 1.

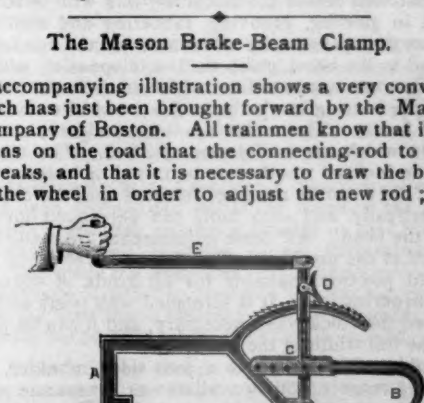
THE SHEFFIELD HAND-CAR AND STEEL WHEEL.

Belts and Dressings.

BELTS should be cleaned regularly, and after cleaning, a good belt-dressing should be applied to keep the belt soft and elastic, and cause it to hug the pulley and transmit its greatest power. The use of a good belt-dressing is superior in economy to any other method for correcting a slipping or slightly loose belt. The custom of tightening a belt whenever it slips is not a good one. The belt is liable to be made too tight, which heats the bearings and strains the belt. Great care, however, should be taken in selecting a belt-dressing. Castor-oil is an article in very general use, but experts have found that it contains an active acid principle, and is drying in its nature. The use of soap, rosin, tar, etc., cannot too strongly be condemned. They are only temporary stimulants, and eventually destroy the belt. A belt-dressing that is guaranteed to prevent slipping, and at the same time keep the leather soft and elastic, is certainly worthy of careful consideration. Such is one made by the Joseph Dixon Crucible Company, Jersey City, N. J. There is no trouble in applying it, and all who have used it commend it in the highest terms.

The Mason Brake-Beam Clamp.

THE accompanying illustration shows a very convenient device which has just been brought forward by the Mason Regulator Company of Boston. All trainmen know that it frequently happens on the road that the connecting-rod to the brake-beam breaks, and that it is necessary to draw the brake-beam toward the wheel in order to adjust the new rod; the same thing frequently has to be done to put a new brake-shoe upon the beam. The ordinary method is to use a screw-clamp, which is a very slow process. With the new device the beam can be instantly brought toward the truck. The hook *B* is passed over the car axle while the other end at *A* is passed over the



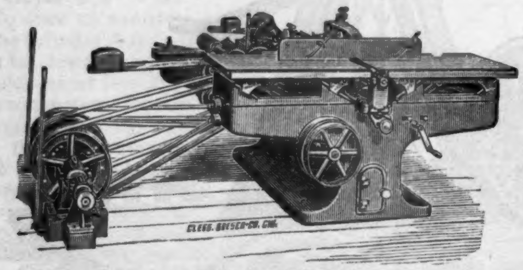
THE MASON BRAKE-BEAM CLAMP.

brake-beam. The beam is then pulled forward by the handle *E*, acting upon the lever *C*, the latter being held in place by the ratchet *D*; the whole forming a very convenient and cheap device.

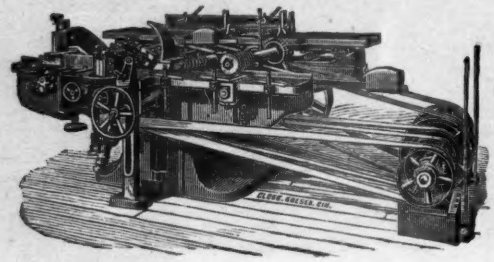
A Compound Universal Wood-Worker and Moulder.

THE accompanying illustrations show a very complete machine which has just been brought forward by the Egan Company, and which combines several improvements resulting from long experience in the manufacture of similar machines.

These two machines, a 9-in. universal wood-worker and an 8-in. four-sided moulder, are on one frame, cast in one piece. They are driven by a patent combined countershaft, which has no loose pulley, and which requires but one belt from the line shaft, thus obviating the shifting of a belt to start or stop either machine. The arrangement of the countershaft is such that each machine is as independent of the other as if they were entirely separate. Both machines can be run at one and the same time, or each independently at different times; all adjust-



WOOD-WORKER SIDE.



MOULDER SIDE.

COMBINED UNIVERSAL WOOD-WORKER AND MOULDER,

With Patent Combined Countershaft

ments can be made; heads and bits can be put on or taken off; and they can be stopped, started and operated without the one interfering with the other in the least. It answers the purpose and does the work of two separate machines, and occupies but little more space, if any, than either a separate wood-worker or a separate moulder.

The wood-worker side consists of a 9-in. universal or variety wood-worker, and has all the adjustments of an independent machine. The mandrel is made of steel, and runs in the patent journal box and slide, by means of which the mandrel has a lateral adjustment across the machine; this will be found very convenient in gaining, grooving, rabbeting and similar work, as it enables the operator, by a few turns of the hand-wheel, to put the head to the exact place wanted, dispensing with adjusting the fence to an accurate line, which is difficult to do. The patent outside bearing can be instantly removed to facilitate the changes of heads. The tables are long, and have a variety of adjustments which are easily accomplished. The tables raise and lower on inclines; both can be raised or lowered together separately; they can be raised or lowered with the circle of the head, or vertically, and each table can be moved horizontally to or from the head. All these adjustments are made from the working end of the machine. The patent bevel fence is made to adjust to positions suitable for all kinds of squaring up, beveling, cornering, etc. It is furnished with posts and springs to hold down the stock when necessary, and it can be placed so as to use the full width of the knife.

The moulder side comprises a four-sided moulder, as complete in every respect, and as available as a separate machine. Three sizes are made: 8 in. 9 in. or 10 in. The bed is gibbed to the main column, working in planed ways, and is adjusted by the large hand-wheel in front. An improved clamping device is provided to firmly clamp the outside bearing and bed to the main column, holding them solid and rigid. The cutter heads are steel slotted on four sides. The two side heads and lower head raise and lower with the bed. Each side head has a lateral adjustment, and can also be beveled. All four heads have a horizontal adjustment by means of the hand wheels in front.

The feed is powerful, and consists of four geared feed-rolls, two above and two in the bed, not shown in cut; the latter are driven by expansion gearing, and the former are arranged to lift parallel; this allows the full surface of the feed-rolls to rest across the board, although it may vary in thickness. The outside bearing to the main head is bolted to the frame and reaches to the floor, and is clamped to the bed. The adjustable box can be removed instantly when a change of heads is desired.

The variety of work that can be accomplished with this combined machine, the ease with which they can be operated together or separately, and the small amount of floor space occupied in proportion to the work that can be done, makes it a valuable tool for a wood-working establishment. It will make all kinds of mouldings, either straight, circular or wave; flooring, ceiling or partition stuff; will do rabbeting, gaining, panel-raising, jointing, ripping, cross-cutting, and a great variety of other work.

Further information about this combined machine can be obtained from the manufacturers, the Egan Company, whose address is Nos. 194–214 West Front Street, Cincinnati, O.

Baltimore Notes.

THE Baltimore & Lehigh Railroad, now 3 ft. gauge, is to be widened to standard gauge. The work on same will begin on September 1, and will be pushed to an early completion, so as to be in a position to interchange traffic with the Baltimore & Ohio upon the completion of the Belt Road.

VICE-PRESIDENT Thomas M. King, of the Baltimore & Ohio Railroad Company, says the through east and west trains will run by way of Connellsville, Pittsburgh Division, in August, and *via* Pittsburgh from Baltimore over the Pittsburgh & Western to Akron, O. At this point connection will be made with the Baltimore & Ohio's Chicago Division by means of the Akron & Chicago Junction Railroad.

AN unusual incident happened recently on the Baltimore & Ohio. An express train was running east early in the morning, and in the forward part of the train was an express car loaded with horses. One of the animals either objected to the rapid rate at which the train was running, or else it desired to give the order for its breakfast, for it raised its head, and taking the cord of the air signal in its mouth, pulled the signal on the engine, causing the engineer to stop the train, and thereby bringing numerous heads out of the windows, to see if something was on the track or off the track, as it was not a stopping place.

THE Baltimore & Ohio is arranging for the construction of six first-class 52-ft. express cars, to be built by the Pullman Company, with stationary safes.

THE Baltimore Electrical Works Company, incorporated some time since, and located at Canton, Baltimore, has its entire plant under roof, is putting in the machines, and expects to have the entire plant in operation by fall. It is the purpose of the Company to manufacture electric machines and appliances of every character.

THE Baltimore & Ohio is constructing several miles of new track, which, when completed, will be known as the New Cut-Off, and will begin at the point of intersection of the Baltimore & Ohio and the Baltimore & Potomac, about three miles east of Relay Station, and run to a point on the Washington Branch between Elkridge Landing and Annapolis Junction. By this additional track the Baltimore & Ohio expects to reduce the time of the New York trains about ten minutes. Messrs. Ryan & McDonald, contractors of the Belt Line Road, have arranged to use the dirt from the Howard Street tunnel for filling on the New Cut-off, and will load the same in cars at Camden Station by means of an overhead railway.

THE Maryland Central Railroad Company and the York & Peach Bottom Railroad Company have consolidated under the title of the Baltimore & Lehigh Railroad Company, and instructions have been issued to have the equipment of the two roads lettered accordingly. It is not yet known whether there will be any change in the management.

THE Baltimore & Ohio's Continental Fast Freight Line will soon be put into operation. The trains for this service will consist of special box and gondola cars, equipped with automatic brakes and couplers. The engines with which the trains will be hauled are equipped with Westinghouse air brake, including the American driver brake.

THE South Baltimore Car Works, Curtis Bay, have arranged with the Baltimore & Ohio to handle 150 thorough repair cars per month.

The Servé Ribbed Boiler Tubes.

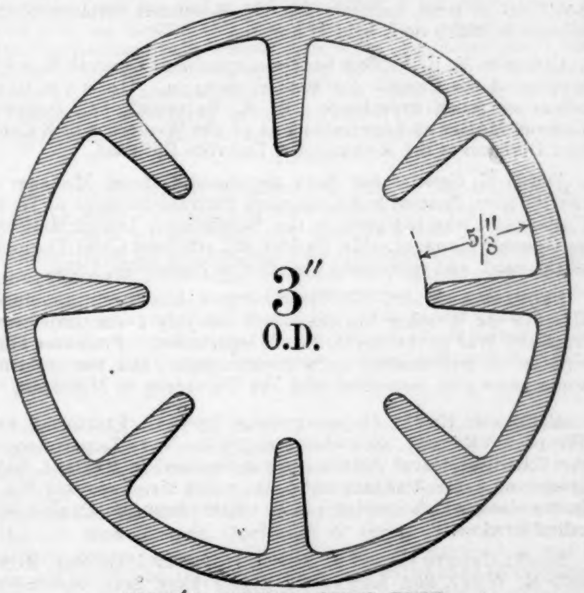
The table below gives in condensed form the result of comparative trials of these tubes, made recently at the shops of the Samuel L. Moore & Sons Company, in Elizabeth, N. J.

The boiler used was an upright tubular of the usual pattern, 42 in. diameter, with 36 in. furnace, 24 in. high, and 63 tubes 2¼ in. in diameter and 6 ft. long; 7 sq. ft. grate surface, 287 sq. ft. heating surface. It was run for six days with plain tubes, and then for six days with Servé ribbed tubes.

Pounds of Coal per 100 Pounds of Water Evaporated.			Economy of coal p.c.	Increase in steam generated
Draft.	Plain tubes.	Ribbed tubes.		
Natural draft ⅜..........	19.72	13.65	30.83 p.c.	18.03 p.c.
Forced draft ½..........	16.7	13.21	21.08 p.c.	30.97 p.c.
Forced draft ⅞..........	21.37	14.8	30.74 p.c.	46.46 p.c.

Increase by Servé tubes over plain tubes.	Total evaporation.	Evaporation per lbs. of combus'n.	Extreme evaporation.
Natural draft ⅛..........	18.03 p.c.	57.54 p.c.	8,460 lbs. for plain tube.
Forced draft ½..........	30.97 p.c.	32.68 p.c.	14,000 lbs. for ribbed tubes.
Forced draft ⅞..........	46.46 p.c.	46.84 p.c.	Increase 65.5 per ct.

Each day's trial lasted 8 hours; 32.35 lbs. of wood and 150 lbs. of coal were used to start the fire and to raise steam to 70 lbs. pressure, after which the trial immediately commenced. Steam was kept at 70 lbs. pressure, and the water level at 7 in. in the glass as nearly as possible, and both were at these points at the end of the trial. In the last day's trial alone, steam was



SERVÉ'S RIBBED BOILER TUBE.

kept at about 100 lbs. pressure in order to obtain the high draft and dry steam. The water level was also about 3 in. in the glass.

The soot scraped out of the plain tubes after the six days' trial was 2½ lbs. That scraped from the Servé tubes after the six days' trial was 3 lbs.

The accompanying illustration is a section of one of the ribbed tubes. They were first illustrated and described in the Journal some time ago.

A New Water Lift.

An arrangement for filling water-tanks for railroad or other purposes has recently been invented by Messrs. Burt and John W. Skilton of Jacksonville, Fla. It is especially adapted for the use of railroads where the motive power is always at hand, and can be used wherever there is a pond or well near the tank. A tank with a bucket containing any desired quantity of water—for service from 1,500 to 2,000 galls. would be most convenient—is made, which can be lowered into the well. The hoisting apparatus by which this bucket is raised is so arranged that a rope can be attached to a locomotive and by running the engine from 200 to 400 ft. along the track, according to the depth of the well, the bucket can be lifted to the level of the stationary tank, when its outlet is automatically opened and the water is allowed to run into the tank. The bucket is then automatically detached from the hoisting rope and falls back into the well, the rate of speed in its fall being regulated by a governor, which is placed upon the ground, and can be attached to the rope holding the bucket.

This apparatus seems to be especially adapted for the use of railroads at stations where it is not convenient to maintain a pumping engine, as a train stopping to water can fill the tank in a very short time, and the expense of maintaining the engine and keeping a man to operate it can be avoided.

This apparatus is to be introduced on several lines in Florida, and will be manufactured by the Acme Water Lift Company of Jacksonville.

General Notes.

The Baltimore & Ohio Railroad Company has contracted for 40 passenger coaches, to be built by Pullman's Palace Car Company. The cars are to be 48 ft. 6 in. long over end sills. It is understood that part of them will be built at Pullman and some at the Detroit shops.

The Consolidated Car Heating Company has established a new department in its business, to be known as the Equipping Department, and it will be under the charge of Mr. J. H. Sewall, as Superintendent of Equipment, with headquarters in Chicago. He will have charge of the application of all the company's appliances on cars throughout the United States and Canada.

One of the largest sailing vessels ever built on the Delaware was launched from the yard of the Jackson & Sharp Manufacturing Company at Wilmington, Del., June 20. This ship is 180 ft. length of keel, 40 ft. beam, and 17 ft. depth of hold. She will have four masts, with a fore-and-aft rig. The masts will be each 97 ft. long and the topmasts 52 ft. long, making the entire length 149 ft. The bowsprit will be 47 ft. in length, and the total sail area will be about 5,000 sq. yds. of canvas. The vessel has steam hoisting engines, and the anchor, sails and cargo will be handled entirely by steam.

The Wason Manufacturing Company, Springfield, Mass., is building 10 passenger cars for the Boston & Maine Railroad to be used in suburban service. They are smaller than the usual car, being only 40 ft. in length, and will have seats for 48 passengers. The cars will weigh 30,000 lbs., and will be handsomely finished. They will be arranged with 16 longitudinal seats at each end, eight on a side, and in the middle three cross-seats of the usual pattern, the general arrangement being very similar to the cars on the New York Elevated Road.

We are informed that in the case of the Dunham Manufacturing Company—now the Q. & C. Company—against the Coburn Trolley Track Manufacturing Company, in the United States Circuit Court for Massachusetts, a final decree and permanent injunction has been granted against the Coburn Company for infringement of patent.

The firm of Gordon, Strobel & Laureau, Limited, of Philadelphia, has become the Philadelphia Engineering Works, Limited. It has added to the business of the old firm a special department for the manufacture of high-class Corliss engines of all types, and high-speed traveling cranes driven by rope, square shaft or electrical transmission of power.

The Pennsylvania Steel Company's Sparrow's Point, Md., branch has been reorganized under the name of the Maryland Steel Company, and has secured a charter in that State. Mr. F. W. Wood, General Manager of the Pennsylvania Steel Company, was made the President of the new company. The change was made in order to facilitate the transaction of business, it having been found desirable to operate under a charter received from the State in which the plant is located.

In the United States Circuit Court at Cleveland, O., the second application of the Pittsburgh Reduction Company for an injunction to prevent the Cowles Electric Smelting & Aluminum Company from manufacturing aluminum has been refused. This is regarded as a decided victory for the Cowles Company.

The National Tube Works Company of McKeesport, Pa., which is chiefly owned in Boston, is to be reorganized. A new company is to be organized under the laws of New Jersey

which will also include the Monongahela Furnace Company, the Republican Iron Works, and the Boston Iron and Steel Company, allied concerns with the same ownership. The new company will have a capital of $11,500,000. The concerns have always been very prosperous, doing a large business.

THE Richmond Locomotive Works, Richmond, Va., are building 10 ten-wheel locomotives, with 19 × 24-in. cylinders, for the Chesapeake & Ohio; 4 eight-wheel engines, with 18 × 24-in. cylinders, for the Seaboard Air Line; 2 eight-wheel passenger engines with 18 × 24-in. cylinders; 7 ten-wheel engines with 17 × 24-in. cylinders, and one switching engine with 17 × 24-in. cylinders for the Louisville Southern; 2 eight-wheel engines for the Wilmington, Onslow & Carolina Railroad.

THE contract for a steel steamer to be used in New York Harbor by the Quartermaster's Department of the army has been let to John H. Dialogue, Camden, N. J., for $57,000. This vessel will be 132 ft. long, and will be propelled by twin screws. The engines will be compound, with cylinders 14 in. and 26 in. in diameter and 18 in. stroke. Steam will be supplied by two boilers 7 ft. 7¾ in. in diameter and 17 ft. long, built to carry 110 lbs. pressure.

THE Allegheny County Light Company in Pittsburgh now has 19 Westinghouse engines running dynamos in its three electric light stations. In Station A there are three 18 × 16 standard, three 8½ × 8 standard, and four 14 and 24 × 16 compound engines; in Station B three 18 and 30 × 16 ompound, two 15½ × 14 standard, and two 13½ × 12 standard; in Station C one 14 and 24 × 14 compound and one 13½ × 12 standard engine. These 19 engines are rated altogether at 3,605 H.P. The only other engine used by the Company is a 500-H.P. Corliss.

THE St. Charles Car Company, St. Charles, Mo., has just completed a number of provision cars for the Armour Company, and is working on orders for 250 box cars for the Wabash; 200 cars for the Iowa Central; 500 cars for the Mexican National, and 500 coal cars for the Choctaw Coal & Railroad Company. The Company has just completed a very handsome passenger train for the St. Louis, Hannibal & Keokuk Railroad, consisting of baggage car, smoking car and two chair cars; the latter are fitted with Scarritt-Forney seats, and the whole train has the latest improvements in heating, lighting, etc. Two chair cars, with Scarritt reclining chairs, and three sleeping-cars are also nearly finished.

IN the new Pennsylvania Railroad Shops at Altoona, a special type of locomotive boiler is used, so modified as to adapt it to the use of a mechanical stoker. The Roney stoker is used here, and in connection with it is a complete plant of machinery for handling coal and ashes, so that the labor in the fire-room is very small. In arranging the engine plant the principle of subdivided power has been adopted throughout, and there are in the shops 17 engines, all of the Westinghouse pattern, as follows: Two 15-H.P., one 25-H.P., and two 50-H.P. Westinghouse junior engines; two 5-H.P., one 25-H.P., and one 35-H.P. Westinghouse standard engines; three 35-H.P., three 65-H.P., and two 80-H.P. compound engines. Steam loops and separators are used wherever necessary to protect the engine and economize fuel. The contract for the entire power and plant was taken by Westinghouse, Church, Kerr & Company.

THE contract for the new cable driving plant for the Brooklyn Bridge has been awarded to the Robert Poole & Sons Company, of Baltimore. The amount of the contract is $69,143.

PERSONALS.

G. L. NICHOLSON is now Engineer and Superintendent of the Chesapeake & Ohio Canal.

J. F. BOYD is now Superintendent of the Montalto Railroad, succeeding the late COLONEL GEORGE B. WIESTLING.

N. O. DUERR, formerly with Messrs. Cofrode & Saylor, is now in charge of the office of the Toledo Bridge Company.

W. J. WILCOX is now Master Mechanic of the Charleston, Cincinnati & Chicago Railroad, with office at Blacksburg, S. C.

W. G. CHOATE is appointed Superintendent of the Rio Grande Junction Railway, in place of THOMAS SAUNDERS, who has resigned.

W. F. DURAND, late of the Agricultural College of Michigan, is now Professor of Mechanical Engineering at Pardue University, Lafayette, Ind.

E. HANDY has been appointed Chief Engineer of the Lake Shore & Michigan Southern Railroad, in place of G. H. KIMBALL, who has resigned.

WILLIAM E. SIMONDS, of Connecticut, has been appointed Commissioner of Patents by the President, to succeed CHARLES E. MITCHELL, who has resigned.

ALBERT N. CONNETT has been appointed Chief Engineer of the Baltimore City Passenger Railroad. He was recently in charge of construction of part of the Broadway cable road in New York.

W. G. WILLIAMSON, late of Montgomery, Ala., is now Assistant Engineer in charge of the Elk River Division of the Mussel Shoals Improvement on the Tennessee River. His headquarters are at Wheeler, Ala.

GEORGE B. BURBANK is now Resident Consulting Engineer to the Cataract Construction Company, which is building the water-power tunnel at Niagara. He was recently connected with the Croton Aqueduct in New York.

FRANK L. NASON, recently connected with the New Jersey Geological Survey, has been appointed Assistant Geologist of the Missouri Geological Survey, and will have especial charge of the examination of the iron ores of the State.

PROFESSOR A. T. WOODS, well known as a writer on mechanical topics, has resigned the professorship of mechanical engineering in the Illinois State University to become Professor of Dynamic Engineering in Washington University at St. Louis.

H. F. PERLEY, Chief Engineer of the Department of Public Works of the Dominion of Canada, has been suspended from office until charges made against him can be investigated. The charges are that he permitted his wife to receive valuable presents from a contractor.

M. L. HINMAN, Treasurer of the Brooks Locomotive Works, has been chosen President o the Lake Shore Bank at Dunkirk, N. Y. Mr. Hinman has frequently been called upon to hold positions of trust, and this election is another instance of the esteem in which he is held at home.

COLONEL V. E. MCBEE has been appointed General Superintendent of the Central Railroad of Georgia. He is a railroad officer of much experience. R. R. BRIDGERS, JR., succeeds Colonel McBee as Superintendent of the Western North Carolina Division of the Richmond & Danville Railroad.

JAMES K. GEDDES has been appointed General Manager of the Bellaire, Zanesville & Cincinnati Railroad in place of W. R. CRUMPTON, who has gone to the Baltimore & Lehigh Railroad as General Manager. Mr. Geddes will continue Chief Engineer of the road, and will retain his office at Zanesville, Ohio.

PROFESSOR MARK W. HARRINGTON has been appointed Chief of the Weather Bureau, which on July 1 was transferred from the War to the Agricultural Department. Professor Harrington is well known as a meteorologist, and has been for some years past connected with the University of Michigan.

ASSISTANT NAVAL CONSTRUCTORS JOHN G. TAWRESEY and WILLIAM VANSANT, who were sent by the Navy Department to the School of Naval Architecture at Greenwich, England, have graduated. Mr. Vansant stood No. 1 and Mr. Tawresey No. 5 in the class, which consisted of 50 officers from the English and other services.

NAVAL CADETS HENRY G. SMITH, HORATIO G. GILMER, RICHARD M. WATT, and LAWRENCE SPEAR have been ordered to duty in the Construction Department—Cadets Smith and Gilmer at the New York Navy Yard, Cadets Watt and Spear at the Norfolk Yard. It is understood that they will shortly be sent abroad to take a special course in naval architecture.

WILLIAM HAMILTON HALL, formerly State Engineer, has been selected by the State Association of Irrigating Districts of California as Consulting Engineer to report on questions of water supply and irrigation, and to supervise the work of the district engineers. Mr. Hall is well qualified for this work by experience, and by his familiarity both with the general question of irrigation and its special applications in California.

CHAUNCEY SMITH, of Cambridge, was appointed Railroad Commissioner of Massachusetts in place of GEORGE C. CROCKER, whose term has expired. Mr. Smith is one of the most eminent patent lawyers in the country, has a thorough knowledge of all mechanical and electrical matters, has taken an active interest in and made a close study of public and social questions. The Executive Council, however, failed to confirm the Governor's appointment, and Mr. Crocker holds over.

OBITUARY.

PROFESSOR GEORGE M. MOWBRAY, who died at North Adams, Mass., June 21, aged 66 years, was a high authority on the use of explosives in engineering work. He was specially well known from the fact that he manufactured the explosives used in the construction of the Hoosac Tunnel.

GEORGE G. HALSTEAD, who died in Paterson, N. J., July 12, aged 45 years, was for nearly 25 years a surveyor, and for years past had been regarded as final authority on boundaries and land titles in Passaic County, and indeed all through the northern part of New Jersey. Few men have had a more thorough knowledge of land surveying and local history.

SAMUEL H. KETTLEWELL, who died recently in Baltimore, was an engineer of considerable experience. He was topographical engineer to the commission which laid down the boundary line between Mexico and the United States about 1850. Later he was employed in surveys made for a canal across the Isthmus of Darien. During the late war he was topographical engineer in the Army of Northern Virginia in the Confederate service.

COLONEL GEORGE B. WIESTLING, who died at Montalto Park, Pa., June 15, aged 56 years, was for a number of years employed on the Pennsylvania Railroad as a civil engineer. Later he was on the Delaware, Lackawanna & Western, and built the long tunnel near Oxford Furnace, N. J. He served with distinction during the War as an officer of artillery. For some years past he has been Superintendent of the Montalto Railroad and President of the Montalto Iron Company.

RICHARD POILLON, who died in New York, July 4, aged 73 years, was an old and successful shipbuilder. He learned the business from his father and conducted it for many years, at first with his brother and later with his son. During the war Poillon Brothers built several vessels for the Government, and about 1872 they built two war-ships for Japan, the first modern vessels of the Japanese Navy. Of late years the firm was chiefly engaged in building yachts, and their yards turned out the *Sappho*, the *Dreadnaught*, and several others famous for speed.

WILLIAM GUSTAVUS WALLER, who died in Baton Rouge, La., June 13, aged 78 years, was born near Schenectady, N. Y. He early became an engineer, and was for a time in government service; later he was employed on the Philadelphia & Reading, and afterward on several railroads in Virginia. He went to Louisiana about 1843, and for many years was a leading civil engineer and surveyor in that State. For many years he kept full and accurate accounts of the state of the Mississippi, and his reports have been frequently quoted and referred to as authority.

GENERAL ALBERT G. BLANCHARD, who died in New Orleans, June 21, aged 81 years, graduated from West Point in 1829, and served in the Army until 1840, when he resigned and settled in New Orleans. He returned to the Army later, and served during the Mexican War. Later he made all the surveys for the old New Orleans, Opelousas & Great Western Railroad, and for several other projected lines. During the late war he served in the Confederate Army, rising to the rank of brigadier-general. Since the war he has been employed as consulting engineer for several important enterprises.

CHARLES ALBERT FESTETICS, who died in Jersey City, N. J., June 25, aged 51 years, was born in Hungary, and served for a time in the Austrian Army. He came to this country in 1866, and was for a time Assistant to General C. P. Stone in the surveys for the Florida Ship Canal. Subsequently he was Constructing Engineer of the Texas & Pacific Railroad. For several years he was on the New York Central & Hudson River, and had charge of the building of the third and fourth tracks between Albany and Buffalo. For several years he was with the Cornell Iron Works in New York. At the time of his death he was Chief Engineer of the Alabama Coal & Iron Company.

EDWARD BURGESS, who died in Boston, July 12, aged 43 years, was born in West Sandwich, Mass., graduated from Harvard College, and was for a short time employed as an instructor there. In 1873 he began a remarkable career as a designer of yachts, and entered into business as a naval architect in Boston. He soon became famous for his fast boats, and over 100 of the most noted American yachts have been built on his designs, including such boats as the *Sachem*, the *Wraith*, the *Titania*, and the three famous flyers, the *Puritan*, *Mayflower* and *Volunteer*. Mr. Burgess served in 1887 as a member of the Naval Board to award prizes for designs of cruisers and battle-ships, and for three years past had been a member of the Board on Life-Saving Appliances in the United States service.

PROCEEDINGS OF SOCIETIES.

New England Roadmasters' Association.—The ninth annual meeting of this Association will be held in Boston, August 19 and 20.

Committees have been appointed to report upon the following questions:

1. Track Joints; trouble experienced with joints now in use, and points which new ones should cover.
2. Fences, Cattle Guards, and Railroad Crossings.
3. Best Method of Securing Rails to Ties outside of Joints; Holding gauge on curves, spikes, braces, plates, etc.
4. To what Extent can Wear on Locomotive Driving-Wheel Tires be allowed before general economy demands that they should be repaired?

International Congress of Geologists.—The Fifth International Geological Congress will be held in Washington, August 26, and the Committee on Organization has already arranged the details. The meetings will be held in the rooms of the Columbian University, where sufficient room has been set aside for this purpose.

The meetings of the American Association for the Advancement of Science, and of the Geological Society of America, which will take place during the week preceding that of the meeting of the congress, will be held in the same building. The daily programme of the several meetings is as follows:

Aug. 19 to 22.—Meetings of the various sections of the American Association for the Advancement of Science. The foreign members of the congress have been made honorary associate members of the association by its council, and are thereby entitled to take part in its geological and archæological excursions in the vicinity of Washington, and to avail themselves of the reduced rates of fare on railroads which are accorded to its members. American members of the congress who are not already members of the association are invited to join it at the present meeting.

Aug. 24 and 25.—Meetings of the Geological Society of America. The foreign members of the congress are likewise invited to attend the meetings of this society, to contribute papers, and to take part in the present meeting.

Aug. 26 to Sept. 2.—Meetings of the International Congress of Geologists.

Besides the regular subjects of discussion, such as unfinished business of the former congress, reports of committees, etc., the Committee on Organization recommends that the following subjects be made special topics for the consideration of the congress at this meeting: (I) Time correlation of the plastic rocks; (1) correlation by structural data; (*a*) by stratigraphical data, (*b*) by lithological data, (*c*) by physiographical data; (2) correlation by paleontological data; (*a*) by fossil plants, (*b*) by fossil animals; or (*a*) by marine fossils, (*b*) by terrestrial fossils: (II) General geological color schemes and other graphic conventions: (III) Genetic classification of the pleistocene rocks.

The Committee has arranged for several excursions to take place after the meeting, in which those attending the Congress, whether from this country or from foreign countries, can take part. A long excursion which will occupy about twenty-five days will enable visitors to see the best scenery and most interesting geological phenomena in the Eastern States, the Mississippi Valley and the Rocky Mountain region, concluding with a week in the Yellowstone National Park. Should sufficient members join, shorter excursions will be made through the South Appalachian region, the copper and iron regions of Lake Superior, and through the oil region of Pennsylvania to Niagara Falls and thence down the St. Lawrence to Montreal and Quebec.

Master Car-Builders' Association.—A circular from Secretary John W. Cloud submits to letter-ballot the various questions which were so referred at the recent convention. They are as follows:

A. On the recommendations made by the Committee on Lettering Freight Cars as to standard practice.

B. On the system of Joint Inspection, the form of Joint In-

spection Agreement, and the rules governing Joint Car Inspection as reported by the Committee.

C. On the form of report of Defective Cars received and delivered which was proposed by the Committee.

D. On the form of Joint Inspection Defect Card proposed by the Committee.

E. On the proposed change of the standard size of pin in the Air-brake Standards of the Association from $1\frac{7}{64}$ in. to $1\frac{3}{32}$ in. in diameter.

F. On rescinding the action of the Association in adopting the Fletcher journal-box lid as a standard.

G. On the adoption of the journal-box, bearing, wedge and lid for 60,000 lbs. cars as submitted by the Committee.

H. On the modification of the old standard Journal-box to receive a lid similar to that proposed for the Journal-box for 60,000 lbs. cars, and the adoption of that lid as a standard.

The votes will be counted on September 2 next, and ballots received after that date will not be admitted.

The Secretary also announces that the Revised Rules of Interchange are now ready for distribution.

Boston Society of Civil Engineers.—At the regular May meeting, in Boston, Mass., James B. Francis and Samuel Nott were chosen honorary members. The following gentlemen were elected active members: William E. Baker, James T. Boyd, Benjamin G. Buttolph, Percy N. Kenway, J. W. Linzee, Jr., and Franklin C. Prindle, Boston; Heywood S. French, Newtonville, Mass.; Lewis J. Johnson, Cambridge, Mass.; Herbert F. Pierce, West Newton, Mass.; Edward W. Shedd, Worcester, Mass.

Mr. C. H. Van Orden presented a paper on the Town Boundary Survey of Massachusetts, which was discussed. Mr. L. M. Hastings read a paper on Problems in City Engineering, which also called out some discussion. Mr. Fitzgerald made a few remarks on the cost and construction of Basin V of the Boston Water Works at Ashland, Mass. The members had visited this work in the afternoon before the meeting.

At the regular meeting in Boston, June 17, the following members were elected: Luther Deane, Taunton, Mass.; Edward Lyman, Lowell, Mass.; Charles T. Main, Lawrence, Mass.; H. J. Morrison, Cambridgeport, Mass.; C. G. Nevers, Frank E. Sherry, Boston, Mass.

Mr. Allen Hazen read a paper on the Mechanical Precipitation of Sewage, giving an account of the experiments made at the station at Lawrence. He stated that there are two ways of purifying sewage; first, by separating the impurities and then removing them; and second by destroying the impurities by chemical means. As to which is to be preferred depends very much upon local conditions. This subject was discussed at considerable length, reference being made to the importance of a constant examination of the character of the sewage to determine the method which could best be used.

Previous to the meeting the Society had an excursion to Lowell, where members inspected the carpet mills, the Merrimac Mills, the locks and canals, etc.

New York Railroad Club.—At the regular meeting in New York, May 21, which was the last meeting of the season, Mr. W. F. Ellis read a paper on Frogs and Switches, calling attention to recent improvements made, and the importance of these parts of the track, especially in view of the increase in weight of engines and speed of trains. The paper was discussed by Messrs. Mitchell, Forney, Ellis, and others.

Engineers' Club of Philadelphia.—The regular meeting of May 16 was devoted to the discussion of Rapid Transit for Philadelphia. Papers were presented by John L. Gill, Jr., and S. L. Smedley on the general question; by G. H. Condict, T. Carpenter Smith, and P. G. Salom on electric railroads. All these were discussed by members present. An elevated line on Market Street seemed to be approved.

At the regular meeting, June 6, the Secretary presented communications relative to the Engineering Congress at Chicago in 1893.

A paper on Rail Joints, by G. W. Creighton, was read, giving results of experiments.

Professor H. W. Spangler presented a model and specimen illustrating a curious case of combined tension and flexure. The specimen in question was square in section at the ends. A few inches from each end it was enlarged on one side and still further enlarged in the middle on the same side, thus giving a much greater area of metal next to the ends, and still a greater area in the middle. The specimen, which had been broken in tension, had not been broken at the ends, but through the section next to the ends, where there was a large increase in area. Professor Spangler then presented a mathematical discussion, showing that this fracture occurred where it did in accordance with strict mathematical principles. This called out some discussion.

Engineers' Club of Cincinnati.—At the regular meeting, June 18, four new members were elected.

Mr. A. S. Hobby read a very interesting paper on Brick Masonry.

Civil Engineers' Club of Cleveland.—At the regular meeting, June 12, Mr. Utley Wedge was elected a member.

Mr. Walter Miller read an interesting paper on Steam Steering Gear for Lake Vessels, and illustrated with drawings the mechanism by which the greatest accuracy is obtained in turning the rudder any desired number of degrees. This was followed by a brief discussion as to the practicability of applying the same or similar arrangement to cranes and other hoisting machinery.

Professor E. P. Roberts then read an excellent paper on Considerations Governing the Choice of a Dynamo, in which the general construction of the dynamo was fully explained, and the good points that one should look for when making a choice were fully gone over. After a short discussion on this paper Mr. F. C. Osborn gave an account of the recent Convention of the American Society of Civil Engineers at Lookout Mountain. The Club then adjourned for lunch.

Western Society of Engineers.—At the regular May meeting in Chicago, J. C. Slocum, W. C. D. Gillespie, William H. Hendren, Theodore W. Parvin, Morgan Walcott, and B. Thomas were elected members.

The Secretary gave some information as to the work done by the General Committee in preparation for the International Engineering Congress in 1893.

A preliminary vote was taken on the question of changing the name to the Chicago Society of Civil Engineers, the result being against the proposed change. The subject will be brought up again.

Mr. T. T. Johnston read a short note relative to Mr. Corthell's paper on the Enlarged Waterway between the Lakes and the Seaboard.

Engineers' Club of Minneapolis.—The regular May meeting was the fourth joint meeting of the St. Paul & Minneapolis Clubs. President Pike of the Minneapolis Club presided. An interesting paper was read by Mr. Woodman of the St. Paul Club on Railroad Tunnels in Wisconsin. Some extracts from this were published last month. A discussion of this paper called out a number of opinions on the best way of ventilating a tunnel. The opinion was expressed that for a single track tunnel 3,800 ft. in length, the best plan yet found was to run a train through quickly and follow it up with another as closely as possible.

At the regular meeting, June 4, the action of the Executive Committee on the International Engineering Congress and on Club headquarters was approved. Mr. Frank Llewellyn was elected a member.

Mr. O. Hoff read a paper on Bridge Erection, calling attention to the fact that details were often so designed that the erection of a bridge cost more than it ought. Couplings should have plenty of play, and field riveting be reduced to a minimum. He described some devices used in erecting, travelers especially.

Northwestern Track & Bridge Association.—At the May meeting in St. Paul, Mr. William McGonagle read a paper on the Best Method of Preserving Timbers, in which he described several processes adopted for this purpose, including creosote, Burnett process, kyanizing, and others, giving the results so far obtained and the cost.

The same gentleman read a paper on Covering the Members of a Howe Truss Bridge, in which he sought to prove from experience that it would be well to do so.

Engineering Association of the South.—A regular meeting was held May 15, at Earlington, Ky. A communication from the Chattanooga *Tradesman* offering a cash prize of $25 for the most meritorious paper presented to the Association during the current fiscal year was received and accepted. Mr.

Gaudenz Luetscher, Ensley, Ala., and Lieutenant John Biddle, U. S. Engineers, Nashville, Tenn., were elected members.

A paper on Coal Cutting Machinery was presented by J. B. Atkinson, Vice-President of the St. Bernard Coal Company. The paper presented a historical account of the development of coal cutting machinery and a comparative study of American machines as compared with those of England and France. The use of electricity as a motive power was thoroughly discussed, and the advantages and disadvantages of the positive feed machines set forth.

During the day of the 15th a very general inspection of the collieries and coke ovens of the St. Bernard Coal Company was made, and the improved system of coal cutting machinery and hoisting machinery was carefully studied and greatly admired. The visiting members were very hospitably entertained at the residence of President and Mrs. Atkinson.

Saturday, the day following, was spent in a yachting and fishing excursion on the lake, the members leaving for their homes Saturday evening. The meeting was one of the pleasantest enjoyed by the Association.

AT the regular meeting in Nashville, Tenn., June 11, the Board of Directors reported that permanent headquarters had been secured in the new Cumberland Publishing House on Cherry Street, Nashville, Tenn. The headquarters comprise a suite of three rooms which may be thrown into one large room 43 × 23 ft. on the second floor of this new building just nearing completion. The headquarters of the Association will be completed and in readiness for occupation before September.

Mr. Mitford C. Massie, Crossville, Tenn., was elected a member. It was decided to suspend the monthly meetings of the Association during the months of July, August, and September, holding the next meeting in the new quarters of the Association at Nashville, October 8.

Mr. J. J. Ormsbee read a paper on Mining Operations in the Sewanee Coal Seam, describing the coal-mines at Whitwell and Tracy City.

Mr. J. H. Heiskell read a paper on Street and Highway Traffic, advocating improvement in vehicles.

Mr. R. L. Johnson read a paper on Capacity of Sewer Pipe to withstand internal strains, giving the result of experiments made at Vanderbilt University, in which 8-in., 15-in. and 24-in. pipes failed at about equal pressures, the tests used ranging from 10 lbs. to 18 lbs. per square inch.

Atlanta Society of Civil Engineers.—This Society has been organized at Atlanta, Ga., with the following officers: President, Grant Wilkins; Vice-Presidents, H. B. Baylor, N. W. Davis; Secretary, Parker N. Black; Treasurer, C. C. B. Haines; Directors, R. M. Clayton, B. M. Hall, W. S. Larendon. The Society will hold monthly meetings. It starts with 22 active members.

Denver Society of Civil Engineers.—At the regular meeting, June 23, Mr. John S. Titcomb read a carefully prepared paper on Irrigating Canals and Ditches, which was generally discussed.

AT the regular meeting, July 14, the subject of Irrigation was continued by a paper presented by Mr. L. G. Carpenter, on Loss of Water in Irrigation, in which he referred at length to the different causes of loss, such as evaporation, seepage, leakage, and others.

Technical Society of the Pacific Coast.—At the regular June meeting a paper by Mr. Jerome Newman on Analysis of Strains in Bridges and Girders was read. It was chiefly mathematical, giving a number of rules and formulæ.

The paper on Hall's Hydro-Steam Elevator, read at the May meeting, was taken up and generally discussed by the members present.

American Society of Mechanical Engineers.—The summer meeting was held in Providence, R. I., the opening session beginning on Tuesday morning, June 16. An address of welcome was made by the mayor of the city, Mr. C. S. Smith, to which President R. W. Hunt responded. At this session several papers were read, including one on Rope Haulage, by R. V. A. Norris; Belt Dynamometers, by S. P. Watt; Belt Testing Machines, by G. I. Olden; and Test of a Triple-Expansion Engine, by J. T. Henthorn.

The Committee on Standard Method of Testing Materials reported progress, and stated that the Committee of the Civil Engineers' Society was also at work upon the same subject, and the final report might be a joint one. The Committee on Standard Methods of Testing Locomotives reported progress. The Committee on Standard Units of Measurement reported some resolutions, which were not then acted upon, but were later referred to the Council for consideration.

At the evening session a number of papers were read, the most important of which were on the Economy of Simple and Compound Engines, by Professor Jacobus; Flexure of Elastic Rings, by Professor De Volson Wood; Premium Plan for Paying for Labor, by F. A. Halsey. Several of these papers were discussed.

Between the sessions on Tuesday afternoon the members visited the Nicholson File Works, Rhode Island Locomotive Works, and the shops of the Gorham Manufacturing Company.

The Wednesday morning session was devoted to the reading of papers, a large number being presented. Two of these called out considerable discussion; one being on Jet Propulsion, by Professor J. R. Webb, and the other on Steam-Engine Jackets, by Professor Thurston. An important paper also was that by W. A. Rogers on Screw Cutting and Index Wheels.

At this session there were also several topical discussions, including one on the Speed of Hot Air Engines; another on the Possible Speed of Corliss Valve Gear, and another on the question as to whether it is better to melt iron in a cupola rapidly or more slowly.

On the same day visits were paid to the works of the Harris-Corliss Engine Company, the Brown & Sharpe Manufacturing Company, and the Armington & Sims Engine Company. In the evening members attended a reception given by the citizens of Providence, which was a very pleasant occasion.

At the Thursday morning session, Mr. H. M. Howe read an important paper on Manganese Steel, which was discussed at considerable length. Professor J. E. Denton read a paper on the Performance of a Worthington High-Duty Pumping Engine, and Mr. W. R. Roney presented one on Mechanical Stokers. A topical discussion was had on Pyrometers. This closed the work of the meeting.

After adjournment, the members went down the Bay to Rocky Point by steamer, where they enjoyed a Rhode Island clam-bake. On the return trip the steamer went as far as Newport. In the evening many inspected the power station of the Narragansett Electric Lighting Company.

On Friday the works of the Corliss Engine Company, the Rhode Island Tool Company, and the American Ship Windlass Company, and the pumping station of the Providence Water Works were visited, the members dispersing to their homes in the evening.

NOTES AND NEWS.

Chiquecto Ship Railroad.—The Canadian Parliament has extended the time for the completion of this work one year. In the debate over the proposed extension, it was stated that the total quantity of clay and rock excavated was 1,745,957 cubic yards, leaving 278,933 yet to be excavated. Besides this the steel rails were all delivered, nearly all the hydraulic machinery, one and one-half miles of single track laid, and nine-tenths of the heavy iron sleepers delivered. The ship cradles were ready, the locomotives are being built in Kingston, and there remains but one mile of grading to do. The reason for the delay was that the company is obliged to excavate for the basins 24 feet deeper than the estimate, in order to reach a solid rock foundation. Another cause was the scarcity of labor, owing to the railroad works in Annapolis and Cape Breton. The total expenditure thus far has been $3,000,000, leaving $2,500,000 yet to be expended in finishing the work.

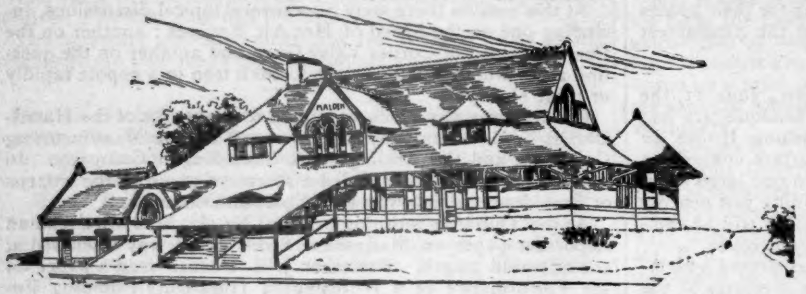
"Engineering Experience."—Not long since, in an arbitration case, an engineer was thus examined as to his professional experience and capacity: "How long have you been in the profession?" "Twelve years." "Are you thoroughly acquainted with your work, theoretically and practically?" "Yes." "Do you feel competent to undertake large constructions?" "Yes, most certainly." "In what engineering works have you been engaged during the last twelve years?" "The manufacture of iron bedsteads."—*Toronto, Ont., Monetary Times.*

A Swiss Railroad Accident.—The Cologne *Gazette* of June 15 has an account of a railroad accident at Basle, Switzerland, in which an excursion train was precipitated into a river and a number of lives lost. That the entire number of passengers was not lost is due to the Westinghouse air-brake. The account says: "The unfortunate train was filled with passengers, because many people from Basle were going to visit the singing festival at Moenchenstein. The new bridge close to the station spans the river Birs, above rapidly flowing waters. The train consisted of two engines, two fast freight cars, and ten coaches. The bridge broke in two. The entire first part of the train was precipitated into the river, but six of the coaches remained on

the track, held there by the tearing apart of the couplings, which brought the Westinghouse automatic brake into action, and resisted further progress. Up to the present 65 bodies have been found; 41 seriously injured passengers are lying in the Basle Hospital. The work of clearing away the débris is being performed slowly."

A New Boston & Maine Station.—The designs of the new Boston & Maine Railroad station to be built at once on the north side of Summer Street, Malden, are finished. The plans indicate a main station 35 × 98 ft., and a baggage house, located south of the depot, 20 × 29 ft.

The building is designed in the romanesque style, erected so as to face the tracks, and distant 39 ft. from the same. The interior is one large waiting-room, 31 × 70 ft., the ticket-office projecting sufficiently to give an ample ladies' room at the north, and the gentlemen's room at the south. In a circular tower at the northwest corner is a ladies' private reception-



room, 18 × 26 ft., with a toilet-room. The ticket-office is circular, with a door entering into the lobby on the south, through which patrons of the road pass in entering or making their exit from the track side. There is also an entrance north of the ticket-office. In the southwest corner is the gentlemen's toilet-room, and in the southeast corner is the agent and operator's room, with entrance from the track side. Surrounding the depot is a broad concrete platform 15 ft. wide. A semicircular driveway, 21 ft wide, with two separate entrances, enables carriages to approach the depot from the west, driving under a *porte-cochere*, which has the monogram "B. & M." on its front. The depot is connected with Summer Street by a 10-ft. walk.

The foundation walls of the main station are to be of good granite block stone. The exterior walls of both buildings above the base courses will be of hard burned brick of the best quality and hardest cull. All the outside walls, as well as the interior of the *porte-cochere* lobby entrance, are to be of best selected hand-made red brick. The filling between the walls of the lobby is to be tiled. The ceilings will be of double-beaded clear whitewood sheathing, and blind nailed, and side walls and all vertical sheathing will also be of the same material.

The wainscot door and window casings, seats, base boards, etc., are to be of clear red oak. All windows and doors are to have plain wide architraves, with edges rounded. There will be whitewood cornices. The toilet-rooms will be tiled with fine white Italian marble, the lobby with Knoxville, Tenn., marble. The door of main entrance from lobby and doors between ladies' room and toilet-room and between the lobby and ticket-office are to have saddles of the same marble, suitably beveled. The toilet-rooms will have Italian white marble skirtings and plinths. The seats will be oak. There will be oak doors. The curved window of the ticket-office will be set in a framework of copper, and there will be more or less copper and wrought-iron trimmings.

South of the main station 15 ft. is the baggage house, a separate, oblong building, 17 × 26 ft., with two doors opening on the platform toward the tracks. South of this is a large open space for express wagons to drive alongside of the platform, which extends to a point near where is located the present depot.

The woodwork of the two buildings will be neatly painted or stained; and although it will be piped for gas, electricity will be the illuminating light. It will be heated by steam, and the ventilation and sanitary conditions will be of the best.

Mr. Arthur F. Gray, of Boston, is the architect, and the contract for the entire work has been awarded to Peabody & Pike. The buildings are to cost $40,000. The accompanying illustration shows this station, which is of very neat design, and harmonizes well with the surroundings.—*Boston Herald.*

The Baltimore Cable Railroad.—The cable road of the Baltimore Traction Company is now in full operation. It extends from Druid Hill to Patterson Parks. Four cables $1\frac{5}{16}$ in. in diameter are used, arranged as follows: A slow-speed cable from the Druid Hill engine-house to the parks, a high-speed cable from the engine-house to Paca and Fayette streets, a slow-speed cable from the same point east through the business part of city to the engine-house on Central Avenue, a high-speed cable from there to Patterson Parks. The citizens are enthusiastically in favor of rapid transit; the cars are crowded with passengers, while the almost parallel routes of horse cars on Madison and Pennsylvania Avenues are scarcely patronized. In fact, so great is the decrease of travel on the horse lines that immediate steps are being taken to cable several of these old routes.

The East African Railroad.—If the despatches from Berlin are correct, the German East African Company has decided to appropriate the sum of $15,000,000 to build a railroad from Tanga, a little seaport about 50 miles northwest of Zanzibar, to Karagwe, the region of which Speke and Stanley gave such glowing reports. It lies a little west of the Victoria Nyanza. The railroad, by starting at Tanga, will avoid the steep climb up the Usugara Mountains, though it will have to make a considerable ascent to reach the interior plateau. It is probable that it will extend nearly due west from Tanga to Tabora, which is the heart of the trade of inner East Africa, and will then turn north and northwest to the Victoria Nyanza and Karagwe. — *Goldthwaite's Geographical Magazine.*

The Manchester Ship Canal.—On June 19 water was admitted into the Manchester Ship Canal at Ellesmere Port on the Mersey, thus marking the approaching completion of this great English work. The water was admitted by a cut in the bank, the opening of the lock gates and the completion of the deep channel having yet to be carried out. There is now a depth of 26 ft. of water from Ellesmere Port to Eastham, 3½ miles, and only a little dredging of the bottom remains to be done. The canal was to be filled with water from Eastham to the mouth of the Weaver about the end of July.

An Unsinkable Boat.—The accompanying illustrations, figs. 1 and 2, represent a steel boat in elevation and plan respectively, which is being introduced by Mr. W. Wells, Leith, Scotland, and which is claimed to be absolutely unsinkable and instantaneously self-righting. The fore-and-aft sections of the boat are constructed in the form of hollow cones, and are thoroughly air and water tight. These are slightly flattened and laid horizontally, and, owing to their peculiar form, impart strength and rigidity to the boat as a whole. The inventor claims that these boats are eminently suitable for pleasure purposes of every description, as they maintain their buoyancy when filled to the gunwale with water; and even if turned bottom upward they instantly right themselves. These boats

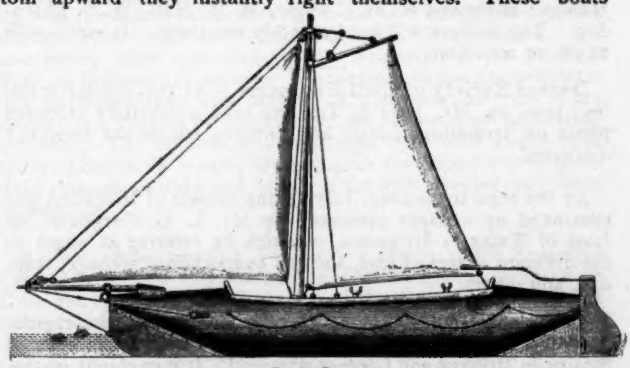


FIG. 1.—ELEVATION.

FIG. 2.—PLAN.

would appear to be especially suitable as an addition to the life-saving equipment of vessels, as, in case of emergency, they could be thrown overboard without the formality necessary with boat lowering gear in use with ordinary punts or dingies, and would instantly right themselves. The boats are put together in sections, and can be disjointed for transportation, and, it is stated, that should both the water-tight compartments be pierced below the water-line, the boats would still remain buoyant. The boats are exceedingly light, one 12 ft. long and 3 ft. beam, with oars, masts, and sail, only weighing 336 lbs. We are informed that these boats have successfully undergone severe tests in the Firth of Forth.—*Industries.*